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THESIS

AN ECONOMIC ANALYSIS OF ACQUISITION OPPORTUNITIES FOR THE UNITED STATES DEPARTMENT OF DEFENSE WITHIN THE JAPANESE DEFENSE INDUSTRIAL BASE

by

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December 2002

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13. ABSTRACT *(maximum 200 words)*

The Japanese Defense Agency (JDA) and the Japanese Defense Industrial Base (JDIB) are in a transitory period. A recession in the Japanese economy, and an increasing requirement for participation by the Japanese military in regional and global venues has placed unprecedented demands on the JDA. The Department of Defense also finds itself in a transformational period, wherein implementation of acquisition reform initiatives is an imperative. Given this environment, this thesis seeks to both provide DoD Program Managers with a baseline economic analysis of the Japanese Defense Industry and identify potential synergies in U.S. - Japan acquisition efforts. An exposition of the Japanese Defense Industry's composition and status, and a targeted comparison to U.S. defense firms, frames the current acquisition environment. Economic factors at work in U.S. - Japan acquisition efforts are identified through examination of past and current acquisition interfaces such as: the FS-X aircraft co-development program, and the Theater Missile Defense program. Specific and general acquisition opportunities are discussed, and an assessment tool for evaluation of collaboration alternatives is proposed. This thesis finds that acquisition opportunities do exist for DoD within the JDIB, and optimization of these opportunities can facilitate DoD's effort to engage in "best-value" acquisition practices.

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AN ECONOMIC ANALYSIS OF ACQUISITION OPPORTUNITIES FOR THE UNITED STATES DEPARTMENT OF DEFENSE WITHIN THE JAPANESE DEFENSE INDUSTRIAL BASE

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ABSTRACT

The Japanese Defense Agency (JDA) and the Japanese Defense Industrial Base (JDIB) are in a transitory period. A recession in the Japanese economy, and an increasing requirement for participation by the Japanese military in regional and global venues has placed unprecedented demands on the JDA. The Department of Defense also finds itself in a transformational period wherein implementation of acquisition reform initiatives is an imperative. Given this environment, this thesis seeks to both provide DoD Program Managers with a baseline economic analysis of the Japanese Defense Industry and identify potential synergies in U.S. - Japan acquisition efforts. An exposition of the Japanese Defense Industry's composition and status, and a targeted comparison to U.S. defense firms frames the current acquisition environment. Economic factors at work in U.S. - Japan acquisition efforts are identified through examination of past and current acquisition interfaces such as: the FS-X aircraft co-development program, and the Theater Missile Defense program. Specific and general acquisition opportunities are discussed, and an assessment tool for evaluation of collaboration alternatives is proposed. This thesis finds that acquisition opportunities do exist for DoD within the JDIB and optimization of these opportunities can facilitate DoD's effort to engage in "best-value" acquisition practices.

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I. INTRODUCTION

A. PURPOSE

The purpose of this thesis is to analyze the Japanese Defense Industrial Base (JDIB), determine what economic factors have influenced the United States Department of Defense (DoD) in past acquisition projects with Japan, and model the impact of economic factors on future acquisition opportunities. The specific goal of this research is to provide DoD Acquisition Program Managers with a baseline analysis that will facilitate the identification of future best-value acquisition opportunities within the JDIB.

B. BACKGROUND

"Japan's defense budget, at around $46 billion, is the world's fifth largest; it annually imports over $2 billion worth of equipment from the United States." [Ref. 41 p. 1]. Japan is also major player in the globalization of the civil-military industrial base. The United States can ill afford to ignore Japan as a cost-effective source of supply for military weapon systems and technologies.

Concurrent with Japan's growth as a global player in the military weapons arena, DoD continues to move forward with numerous acquisition initiatives. These acquisition initiatives include reducing both initial acquisition cost, and Total Ownership Cost (TOC). The JDIB might prove to be a prime market for innovative technologies that could help to reduce acquisition cost and TOC.

DoD has already recognized the need for an integrated civil-military industrial base vice promoting a defense-unique industrial base. The next step in this process is to "globalize" the civil-military industrial base in order to increase competitiveness, increase the opportunity for strategic partnerships, and create an overall best value for DoD. The JDIB has the potential to be a major player in this global market and become DoD's strategic partner (or competitor).

A history of past acquisition interactions between the U.S. and Japan depicts a mixed bag of successful and not-so-successful projects. While there is no clear agreement on the reasons for either success or failure, a few central themes are present:

-Current Japanese policy severely inhibits (though it does not entirely prohibit) the export of military weapon systems. In the last two decades this policy has been progressively revised. Revisions of this policy have enabled greater interaction between the U.S. and Japan on defense-related projects.

-Japanese industry views indigenous military production as an activity with very low potential profits. This view results in Japanese military products that are generally considered inferior to the military weapons production produced by other industrialized nations (e.g. the U.S. and the European Union (E.U.)).

-The Japanese government will usually favor domestic defense procurement/production in order to sustain certain defense sectors (e.g. military aerospace), even when this action results in delivering to the Japanese military a lower quality product at a higher cost (i.e. a better quality product might have been imported at a lower cost).

-The Japanese government is willing to make exceptions to arms export and production policies for the U.S. This willingness to make exceptions for the U.S. may prove to be a comparative economic advantage.

These four themes share a common thread in that they identify the delicate balance between Japanese policy imperatives (i.e. pacifism, regional stability), the need for national security, and the growing globalization of the defense industry. This work seeks, in part, to identify some of the economic aspects of this balance and explore how DoD might create or encourage defense industry cooperation that is advantageous to both countries.

The issues of how and when to conduct acquisition interfaces with Japan are highly relevant in today's acquisition environment. In a September 2000 speech to the Defense Acquisition and Procurement Seminar in Singapore; the Deputy Director of Strategic and Tactical Systems for the Under Secretary of Defense (Acquisition, Technology, & Logistics)-Dr. Paris Genalis, stated that the preferred model for future industrial consolidation is:

> ...what we might call a "competitive, international industrial model, characterized by industrial linkages of multiple firms effectively

> competing in all markets - and sharing technology. In this (preferred) model, the benefits of competition are realized; large markets are opened up to transnational firms; and proliferation incentives are significantly reduced. [Ref. 16 p. 6].

Dr. Genalis concludes his speech by noting that:

> Industrial globalization is taking place, with very little likelihood that we could-or should-do anything to delay or prevent it...we must embrace it, without looking back, with an eye to making it serve both our industrial needs and our security strategies. [Ibid p. 7].

In 2002, the worldwide defense industry is increasingly competitive across a broad spectrum of firms. DoD Acquisition Program Managers can take advantage of one aspect of this global defense marketplace by understanding the Japanese defense industry. Program Managers may assess the Japanese defense industry as a potential competitor or a strategic partner and use this assessment to guide their acquisition decisions.

C. RESEARCH QUESTIONS

1. Primary Research Question

The primary research question explored in this thesis is: What acquisition opportunities exist for DoD within the JDIB? The research is designed so as to enable an exploration of the JDIB that focuses on identification of key factors that create or inhibit acquisition opportunities for DoD.

2. Secondary Research Questions

The secondary research questions explored in this thesis are:

-What are the similarities and differences between the JDIB and the USDIB?

-What economic factors have influenced past US-Japan acquisition projects?

-What are the most likely areas for future acquisition interface with the JDIB?

-How can DoD Program Managers evaluate the costs and benefits of engaging in acquisition projects with the JDIB?

-The secondary research questions are structured so as to: (1) enable the definition of the JDIB; (2) identify and analyze any economic factors at work in US-Japan acquisition interfaces; and then (3) identify specific economic objectives that may facilitate the evaluation of acquisition opportunities in pursuit of the primary research question.

D. SCOPE OF THESIS

This thesis examines the composition and status of the JDIB and makes a targeted comparison between the JDIB and the USDIB to provide a frame of reference for DoD Program Managers. Once the JDIB is compared to the USDIB, the research effort focuses on an analysis of economic aspects in past and on-going U.S. - Japan acquisition interfaces. Next, specific and general acquisition opportunities are identified and a tool is presented for use as modified cost-benefit analysis of acquisition opportunities to evaluate the advantages and disadvantages of collaborative acquisition projects with Japan. In the final chapter, conclusions and recommendations are made concerning how best to implement future acquisition interfaces with Japan.

While issues of national security and policy are present in this examination of the defense industrial base, no attempt is made to comment upon these policies, save for the impact of these policies upon arms sales and arms export activities. In addition, this work will not focus on an examination of the USDIB, except as to provide some comparative reference for the reader. Finally, this thesis does not undertake an overall examination of either the DoD acquisition process or the details of past US-Japan acquisition interfaces. Rather, this thesis focuses on identification and evaluation of economic forces at work in selected acquisition interfaces. The research assumption is that identification and evaluation of any economic forces present (or absent) in past and on-going acquisition interfaces can help to define future acquisition opportunities.

E. METHODOLOGY

The methodology used in this thesis research consists of the following six steps:

-Step 1: Conduct a literature search of books, magazine articles, journals, World Wide Web, DOD references, and other library information resources.

-Step 2: Evaluate the impact of any economic factors on past, and on-going, acquisition interfaces.

-Step 3: Identify specific and general acquisition opportunities for DoD.

-Step 4: Conduct a cost-benefit analysis of undertaking acquisition projects with the JDIB.

-Step 5: Conduct a review of applicable Acquisition Regulations beginning with the Federal Acquisition Regulations (FAR).

F. ORGANIZATION

Chapter II surveys the JDIB and compares it to the USDIB. The USDIB and JDIB are compared to highlight the similarities and differences between the two defense industries. Chapter II concludes with an examination of how the JDIB interacts with its own military and how this interaction affects overall JDIB expansion opportunities and its competitiveness in the world market.

Chapter III examines the economic factors present in U.S. - Japan acquisition interfaces. The focus of this chapter is to identify and evaluate the key economic factors that may influence future U.S. - Japan acquisition projects. This chapter concludes with the identification of four economic factors that influenced U.S. - Japan acquisition interfaces

Chapter IV identifies specific and general acquisition opportunities for DoD. In Chapter IV the researcher presents a tool for assessment of collaborative acquisition projects. This tool is a modified form of cost-benefit analysis. In a sample application, the tool is applied to a past U.S. - Japan acquisition interface (the FS-X). This Chapter concludes with a discussion of alternative assessment tools and a discussion of opportunities for acquisition policy development.

In the final chapter, conclusions are drawn, and recommendations are made as to how DoD should attempt to conduct future acquisition interface with Japan. Chapter V also briefly outlines areas for further research in the collaborative acquisition process.

G. BENEFIT OF THE STUDY

This study will provide DoD Acquisition Program Managers with a baseline analysis that will facilitate identification of acquisition opportunities within the JDIB and contribute to lower initial acquisition costs and lower TOC for future defense acquisitions.

II. ANALYSIS OF THE JDIB

A. INTRODUCTION

The Japanese defense industry experienced significant change in the last quarter of the 20th century. Perhaps the most pivotal event in the recent history of the Japanese defense industry was the fall of the USSR, which caused Japan to undertake a fundamental reassessment of its defense posture. Japan determined that it did not need to spend as much on defense as it had spent during the Cold War-"double-digit defense spending increases that were common in the 1980s (were) replaced by annual increases lower than present inflation rates, resulting in negative real growth in the country's defense budget." [Ref. 6 p. 369]. This cut in defense spending has severely impacted defense acquisition as well:

> ... Japanese Fiscal Year (JFY) 1991 represented the last substantial hike in (defense) spending...Procurement programs in particular dropped dramatically (during 1993-1997). Procurement funding represented 28 percent of the Japanese Defense Agency (JDA) budget in JFY 1989; by JFY 1996, that had dropped to 18.9 percent. [Ibid pp. 376-378].

However, Japan still recognizes the need for strong national defense and a strong defense industry.

In "Country Survey XIII: Japan's Security Posture and Defense Industry Prospects," Michael Chinworth notes that, despite real reductions in defense spending, an examination of current defense budgets "at average exchange rates for the present period (1997), Japan ranks in the top five in terms of military spending globally, a surprisingly high level for a country committed to minimizing its defense spending." [Ibid p.378]. There are funds available for defense-related procurement in Japan, despite declining budgets. The JDIB is considering expansion "into overseas markets to offset declining domestic markets." [Ibid p. 369]. To fully understand what expansion into "overseas markets" actually means for the JDIB, we must first appreciate the constraints faced by the JDIB.

In this chapter, the current restraints on the JDIB are explored, and the current composition and status of the JDIB is outlined and defined. The current composition and

status of the USDIB is also defined (in a limited scope) primarily to facilitate an economic comparison to the JDIB. This economic comparison is intended to provide a relative benchmark for the reader and enable an initial awareness of the potential synergies and dissimilarities of the defense industries of the two countries. The chapter concludes with a discussion of the interface between the JDIB and the Japanese Self-Defense Force (JSDF) and the implications of this interface on the future growth and direction of the JDIB. A summary of key facts about the JDIB is provided at Appendix A.

B. CURRENT RESTRAINTS ON THE JDIB AND EXCEPTIONS TO THOSE RESTRAINTS

The JDIB faces a number of restraints in its ability to manufacture, sell, and distribute arms. This section outlines current restraints on the JDIB. These restraints are not absolute, however, and the last topic in this section outlines exceptions to these restraints.

1. Three Principles on the Prohibition of Arms Export

In 1962 the Japanese government established what became known as the "Three Principles" on Arms Export. The "Three Principles" were further amended in 1976. In their current form the "Three Principles" state that:

> The export of arms shall be prohibited to: (1) Communist bloc countries; (2) Countries to which the export of arms is prohibited under U.N. resolution; (3) Countries involved in or likely to become involved in international conflict; (4) The export of arms to other areas shall be restrained in line with the spirit of the Constitution, and (5) Equipment related to arms production shall be treated as if it were arms. [Ref. 22 p. 91].

In sum, these principles would seem to relegate the JDIB to purely internal defense production. Indeed, the "Three Principles" were intended to mirror Japan's overall "defensive" military posture. However, Japan's mutual defense relationship with the United States, recent economic woes, and the failure of Soviet communism, have all contributed to changing these principles. The United States, in particular, is seen as a strategic partner to Japan's defense industry rather than as a "country involved in or likely to be involved in international conflict." [Ibid p. 91].

2. Exceptions to Restraints

In 1983, seven years after revision of the Three Principles, Japan decided to "open the way for the transfer of its military technology to the United States as an exception to the Three Principles on Arms Exports..." [Ref. 15 p. 132]. This "exception" on arms export has manifested itself in the form of nine cooperative research projects between the U.S. and Japan. These nine research projects[1] are:

(1) Ducted Rocket Engine, (2) Advanced Steel technology (for submarine hulls), (3) Combat Vehicle Replacement, (4) Eye-safe Laser Radar, (5) Improved Ejection Seats (pilot restraint devices and seat stabilizing equipment), (6) Advance Hybrid Propulsion technology (solid fuel with liquid oxidizers), (7) Shallow-sea Region Acoustic Technology, (8) Ballistic Missile Defense Technology, and (9) High-safety gunpowder for Field Artillery (designed to reduce the occurrence of in-bore explosions). [Ibid p. 132].

This cooperative research effort is just one example of Japan's willingness to make exceptions for the United States in the area of arms research and production. Another notable effort is the Acquisition and Cross-Servicing Agreement (ACSA) between Japan and the United States.

The ACSA took effect in October 1996. The ACSA's basic principle is that "if either side requests the provision of goods or services the other side should provide those goods and services.[2]" [Ibid p. 132]. The ACSA was initially applied to "joint exercises, UN Peace-Keeping Operations and international humanitarian relief operations." [Ibid p.132]. This agreement was further revised and, as of September 1999, the ACSA also covers "measures for dealing with situations in areas surrounding Japan." [Ibid p. 128]. The ASCA further erodes barriers to acquisition interface between the U.S. and Japan; however, the 1999 amendment does specifically prohibit the JSDF from providing weapons or ammunition.

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[1] A brief description of each project is contained in Appendix B.

[2] "Goods and services" are defined by the Japanese Defense Agency as: food, water, billeting, transportation (including airlift), POL (petroleum, oil, and lubricants) clothing, communications, decontamination services, base support storage, use of facilities, training services, spare parts and components, repairs and maintenance, and airport and seaport services.

The provision that support by Japanese forces only occur in areas surrounding Japan has also seen revision as a result of the September 11, 2001, terrorist attack on the United States. During October 2001:

> the Japanese government approved legislation that would allow its troops to give logistical support to America and its allies in military operations overseas...the legislation has a clause which causes this exception to expire in two years, however, support for the measure was strong throughout Japan. [Ref. 6 p. 1].

DoD Acquisition Program Managers should note that there are already a number of U.S. - Japan defense-related interfaces in place within the overall Japanese defense establishment. The U.S. is given special consideration with respect to arms export policies and defense-related interactions. This exception may create a comparative advantage for DoD when competing contracts for support of weapons systems or in the Research and Development phase of weapon system's design. DoD Acquisition Program Mangers should recognize that, despite the presence of the "Three Principles," the JDIB might be considered in a number of acquisition venues. In order to fully appreciate the possible avenues for acquisition opportunities, the Program Manager must first understand the composition of the JDIB.

C. CURRENT COMPOSITION AND STATUS OF THE JDIB

1. Composition

The JDIB is "dominated by twelve companies that account for approximately 95 percent of the JDA's acquisition budget." [Ref. 41 p. 2]. These twelve companies (and their primary defense-related emphasis) are listed in Table 1 below:

Defense Company Name	Primary Defense-Related Emphasis
Mitsubishi Heavy Industries, Ltd. (MHI)	Ships, military vehicles, aircraft*, and missiles
Kawasaki Heavy Industries, Ltd.	Ships and aircraft (primarily helicopters)
Ishikawajima-Harima Heavy Industries, Co., Ltd.	Ships and engines
Mitsubishi Electric Corporation	Electronics and Missiles
Toshiba Corporation	Electronics and Missiles
NEC Corporation	Electronics
Fuji Heavy Industries, Ltd.	Aircraft
The Japan Steel Works, Ltd.	Artillery
Komatsu, Ltd.	Small arms/ordnance and military vehicles
Hitachi, Ltd.	Electronics and military vehicles
Oki Electric Industry Co., Ltd.	Electronics
Daikin Industries, Ltd.	Small arms/ordnance

Table 1. Twelve Leading Japanese Defense Companies
[From: Ref. 41 p. 2]

*MHI is Japan's sole producer of fixed- wing fighter aircraft

The defense industry only accounts for about 0.6% of Japan's domestic production. Although this is a small percentage, it still amounted to an R&D and procurement budget of about $10 billion in JFY 1999 (April 1999-March 2000). In concert with these twelve companies, the JDA normally procures defense items through one of the following five sources: "(1) domestic development, (2) co-development with the United States, (3), Licensed Production, (4) Commercial Imports, and (5) Foreign Military Sales. The twelve companies are heavily involved in licensed production

particularly, with U.S. firms" [Ibid p. 1]. It is noteworthy that a significant portion of the ($10 billon) R&D and procurement budget is:

> devoted to only four very expensive programs: the Multiple Launch Rocket System (MLRS), the AWACS airborne early warning system, the Mitsubishi/Lockheed Martin F-2 air superiority fighter aircraft (formerly called the FSX), and the AEGIS guided missile cruiser. All of these are being either license-produced, imported, or jointly developed with the United States. [Ibid pp. 1-2].

The limited composition and constrained nature of the JDIB has significant ramifications for its current status and portends change in the near future if the Japanese government wants to maintain a relatively robust and diverse defense industrial capability.

2. Status

The JDIB faces consistently declining defense budgets and a constrained market structure (as described earlier). The general attitude among the major defense companies is that the JDIB must simply try to survive this fiscally austere period. As a result of this survivalist mentality, the JDIB consistently supports Japanese government initiatives to "rationalize the domestic arms industry." [Ref. 6 p. 392]. "Rationalize" has become "a code word for providing more subsidies to maintain excess capacity until the present dearth of new orders passes (whenever that day arrives)." [Ibid p. 392]. A subsidized defense market may not be the most economical solution for the JDIB and DoD might facilitate implementation of some incentives to reduce Japanese government subsidies by encouraging corporate partnerships with U.S. defense firms.

The United States is viewed as the most likely market for sales of Japanese defense products, primarily due to the constitutional exception to arms exports discussed earlier. The effort to sell defense products to the U.S. has been warmly received by DoD:

> At a higher level within the Defense Department, officials are examining long-term options that range from expanded use of contract research programs to joint production of common components and even expanded purchases of Japanese components to further the objectives of gaining access to Japanese technologies, maintaining common systems, and controlling weapon systems costs. It is not an exaggeration to assert that DoD is more committed to mutually beneficial relationship. Most of these initiatives include some measure of government activism and support. Defense officials in the United States, however, seek an environment in

> which company-to-company interactions will increasingly define technology opportunities for the two countries. [Ibid p. 392].

This initiative by DoD has received a lukewarm response from the JDIB. Most "defense producers seem more interested in new production programs that will increase orders than in research programs involving possible cost/risk sharing and long term horizons lacking any guarantees of moving into production." [Ibid p. 392]. This lukewarm response may be the result of DoD not properly structuring incentives for companies in both countries. The nature and structure of defense production incentives is examined in the next chapter.

The JDIB has undertaken internal measures to improve defense productivity and achieving best value defense procurement solutions. The industry is moving unilaterally (vis-à-vis the Japanese government) to minimize risks and cut costs. "A few major firms have consolidated their defense divisions into new, jointly-owned ventures to reduce costs and minimize risks associated with remaining active in declining markets" [Ibid p. 388]. For example, Ishikawajima-Harima Heavy Industries and Sumitomo Heavy Industries established "equal partnership in an engineering firm to handle research and development, design and life-cycle support for naval vessels" [Ibid p. 388]. This effort will only have a limited effect, however, in that it is actually a reorganization and downsizing of the excess capacity that was present in the market. While potentially effective, these measures will not eliminate the continued need for foreign defense products.

Historically, over 50 percent of Japanese defense imports will come from the United States. However, the Japanese government imports defense items in other markers. Japan sometimes conducts defense acquisition with suppliers in the European Union (E.U.). An example of this effort is the joint venture between "French-German manufacturer Eurocopter and Kawasaki Heavy Industries of the EC-145/BK-117 multi-use helicopter." [Ref. 15 p. 1]. This highly-successful helicopter project launched its second version in 2001 with a "pre-production order quantity of 40 aircraft." [Ibid p. 1]. Japan’s willingness to use E.U. sources for defense contracts creates the potential for the United States and Japan to become competitors in the European defense market. A

competitive European defense market creates a new dynamic in defense procurement for both the United States and Japan that may enable creation of strategic threats and strategic opportunities for the JDIB.

In summary, the JDIB is a relatively small industry that counts upon government subsidies and domestic defense production to maintain both capacity and capability. Defense-related production is seen as a low-profit/no-profit venture and is not considered a major factor in most firms' revenue streams. The "Three Principles on Arms Export" still effectively exist, but are often favorably interpreted for U.S.-related defense projects. The United States is given preferential treatment as a supplier and customer in the Japanese defense market (although some items are purchased or co-produced with EU member nations) and licensed production of U.S. defense items is viewed as an acceptable substitute when domestic production is not possible. The Cooperative Research Effort, the ASCA, and post-September 11th legislation are all prime indicators that Japan and its defense industry are willing to pursue cooperative efforts in the area of defense production. A key element of any cooperative effort is interface with the USDIB. The USDIB shares some similarities with the JDIB and an overview of the USDIB provides a comparative reference. This overview is undertaken in the next section.

D. CURRENT COMPOSITION AND STATUS OF THE USDIB

1. Composition

The top 15 U.S. Defense Contractors account for about 44% of all DoD contracts (about $52.3 billion). While the U.S. defense industry is more diverse (in terms of the number of companies), there are only about twelve companies that routinely obtain more than one percent of DoD contracts in a given year. The top 12 defense companies for FY 1999 and their primary defense emphasis are listed in Table 2:

Defense Company Name*	Primary Defense-Related Emphasis
Lockheed Martin Corporation	Aircraft and Missiles
Boeing Company, Inc.	Aircraft
Raytheon Company, Inc.	Missiles
General Dynamics	Ships and submarines
Northrop Grumman	Aircraft
United Technologies	Aircraft and Helicopter Engines
Litton Industries, Inc.	Ships
General Electric	Aircraft and Helicopter Engines
TRW Inc.	Electronic systems and support
Textron, Inc	Tilt-rotor aircraft, tank engines, helicopters
Science Applications International	Programmic, logistical and technical support
The Carlyle Group	Ordnance, fighting vehicles

Table 2. Top Twelve United States Defense Companies (FY 1999)
[From: Ref. 20 pp. 1]

*Recent mergers may render this list inaccurate, an updated list may be obtained from the website listed at Reference 20.

The overall USDIB encompasses many more firms than the 12 companies listed in Table 2. It is important to note, however, that despite the relative breadth of the defense industry (in terms of number of companies) its overall health is dependent on the viability of the large corporations at the top of the industry. Only the very large corporations possess the capital necessary to undertake large defense projects and many smaller defense-related companies are almost wholly dependent upon subcontracts from the major corporations.

2. Status

The United States spends about three percent of its GDP on its defense budget (as opposed to less than one percent for Japan). The total U.S. defense budget for FY 2002, at approximately $275 billion, represents a marked increase in defense spending. However, throughout the 1990s, the United States defense budget was in relative decline with little money available for large-scale re-capitalization. Thus, the U.S. defense industry began to restructure itself.

Until very recently, the USDIB was faced with the prospects of consistently declining defense budgets (particularly the procurement portion of the budget) and chronic overcapacity. The capacity problem was mitigated by a number of mergers and acquisitions among defense companies during the 1990s. This merging of players within the USDIB could create an oligopoly of defense suppliers within the USDIB and inhibit DoD's ability to competitively award defense contracts to U.S. firms. DoD tends to downplay the impact of defense industry mergers on competition. The Office of the Deputy Undersecretary of Defense for Industrial Policy has stated: "Defense industry consolidation and restructuring will probably continue (into the 2000-2010 decade), although differently than we saw during the 1990s, which was characterized by mergers and acquisitions by the largest defense firms as they became larger...(however) the defense industrial base continues to be a competitive environment which promotes cost savings and competition." [Ref. 32 pp. 1-2].

DoD has not always downplayed the effects of U.S. defense industry consolidation. During 1993-1998, DoD advocated defense industry mergers and acquisitions as a way to realize cost savings for both the industry and the USG. "Unfortunately, the sharing of these cost savings between government and the companies intended by DoD policy and anticipated by defense firms did not happen......" [Ref. 22 p. 140]. In 1998, DoD essentially reversed course when it turned down the proposed acquisition of Northrop by Lockheed Martin and "the proposed acquisition by (a re-emergent) General Dynamics of Newport News Shipbuilding. But DoD did not indicate whether further downsizing was necessary and if so, how it was to be achieved" [Ibid p. 141]. The USDIB seems to be left with no clear direction about consolidation. The

consolidation problem is not likely to be resolved in the near future and despite recent increases in defense spending, it appears unlikely the USDIB will remain at its current size.

In an effort to ameliorate some of the effects of shrinkage in the defense market, the USDIB has looked to other areas for revenue:

- The "industry has aggressively expanded its share of the international arms market, but the potential here is limited by export controls on the most desirable high-performance systems and by the shrinking size of this market." [Ibid p. 143].

- The USDIB looks to the E.U. for defense customers. However, the EU also has "too much industrial base for anticipated defense needs" [Ibid p. 143], and this market does not present itself as able to absorb the current overcapacity in the USDIB.

- The U.S. "defense and aerospace companies have been aggressively seeking ways to enter commercial markets. An individual company may or may not be successful in this effort; the record indicates that larger companies will find it difficult to be competitive" [Ibid p. 143].

The USDIB is aggressively seeking new markets for its products. However, each venue represents difficulties that ultimately indicate that the USDIB will need to find other methods to deal with chronic overcapacity. Interaction with the JDIB (with DoD as an enabler) appears to be an attractive addition to the venues outline here.

The USDIB is comprised of many large and small firms. However, most large defense contracts are dominated by a collection of 12-15 major defense contractors. These U.S. defense contractors participate in an industry that is increasingly diverse and highly-competitive. This market has the potential to include Japanese contractors to a greater extent than the current level of interaction. DoD Program Managers should understand the similarities and differences between the JDIB and USDIB to fully enable cooperation and create best value results. A comparison of the JDIB and USDIB is undertaken in the next section.

E. COMPARISON OF THE JDIB AND USDIB

The following section compares the JDIB and USDIB in four areas: competition, market structure, key governmental issues, and growth potential. The purpose of this section is to outline similarities and differences between the two defense industrial bases and provide a baseline for further examination of economic issues that impact interaction between the industries. This examination begins with a look at competition in each industrial base.

1. Competition

a. Overall Competitive Environment

The JDIB has essentially no intra-industry competition. Contracts are awarded in a basically non-competitive environment and the awards usually make up only a small percentage of the companies' yearly revenue.

> (One) of the peculiarities of Japanese defense contracting (is that) most contracts (in terms of value) are awarded without competitive tendering through a procurement committee to individual contractors. The most common form of procurement contract is the firm-fixed price (FFP) plus a variable fee. The allowable items for determining costs in these negotiated contracts (competitive bidding is rare) are more generous than those usually seen in comparable U.S. procurement contracts, raising the price of military equipment to the Defense Agency and subsidizing the domestic industry......Non-competitive awards comprised 97.4 percent of all JDA contracts in value in JFY 1996. [Ref. 6 p. 381].

In comparison, the U.S. defense industry is highly-competitive. Although the industry has consolidated, competition remains a key element of the industry. In FY 1997, non-competitive awards comprised only 30.4 percent of all procurement contracts that were available for competition. [Ref. 13 p. 1]. While intra-industry competition is keen within the USDIB, U.S. defense firms also aggressively compete in foreign markets.

b. Foreign Military Sales (FMS)

The FMS market for the USDIB is a multi-billion dollar industry. Table 3 (below) provides data on the top 15 FMS (U.S.) Contractors in 1999:

TOTAL PURCHASES $6,216,712,000

Rank	Parent Company	Amount ($000s)	Share of Total Purchases
1	Boeing Co.	$1,417,288	22.80%
2	Lockheed Martin Corp.	1,079,327	17.36
3	Raytheon Co.	813,537	13.09
4	United Technologies Corp.	265,131	4.26
5	Textron Inc.	201,337	3.24
6	Science Applications Intl. Corp.	155,007	2.49
7	Northrop Grumman Corp.	148,732	2.39
8	General Electric Co.	139,308	2.24
9	Mobil Corp.	97,655	1.57
10	VSE Corp	97,298	1.57
11	TRW Corp.	90,329	1.45
12	BDM Corp.	77,001	1.24
13	Rolls Royce PLC	71,976	1.16
14	Booz, Allen & Hamilton Inc.	68,098	1.10
15	Rockwell International Corp.	64,333	1.03

Table 3. 1999 Foreign Military Sales Contractors
[From: Ref. 18 p. 1]

note: Rankings are based on prime contracts of $25,000 or more for military R&D, services and products sold to non-U.S. governments.

FMS contracts generated over $6 billion in revenue for U.S. contractors in 1999. In contrast, the JDIB has essentially no market for FMS because of the restrictions placed upon it by the "Three Principles". It is interesting to note however, that the DoD does provide revenue to Japanese contractors.

> In FY 2001, (DoD) awarded $117,979,880 in prime contract actions performed in Japan......Among the largest dollar values with particular contractors, $33,808,916 was with Sumitomo Heavy Industries and Japan Air Manufacturing, $14,055, 203. [Ref. 10 p. 1].

While the JDIB does not benefit from a $6 billion FMS market, it does benefit from some "foreign contracting" with DoD. This exception is an example of the comparative advantage that DoD has in the Japanese defense market.

The JDIB operates in an essentially non-competitive environment and enjoys none of the benefits of a strong FMS market. The USDIB operates in a highly-competitive environment with a robust FMS market. This environment might indicate that the market structure of these two industries is entirely different. However, a closer examination reveals a number of similarities in market structure between the two industries.

2. Market Structure

As noted above, 95% of JDA's acquisition budget is accounted for by 12 Japanese firms, while 15 companies in the USDIB account for 44% of all DoD contracts. In terms of overall market structure, the prime defense market in both countries is concentrated in a relatively small number of firms at the top of the industry. Table 4 (see next page) provides a side-by-side comparison of the top ten firms in each industry for FY 2000.

Table 4 highlights three market structure similarities between the USDIB and the JDIB. These three similarities are:

-A relatively small number of companies dominate the majority of defense awards. Large prime contracts are dominated by only two or three firms. Table 4 illustrates that 53% of the total awards went to the top two firms in each industrial base.

-The top defense companies are usually comprised of manufacturers of aircraft and missiles. In Table 4 the top three U.S. manufacturers are primary producers of either aircraft or missiles and top three Japanese producers include its only maker of fighter aircraft and its prime producer of rotary wing aircraft.

-Although there is some market exit and entry at this level, the same companies can generally be found within the top 10-15 firms from year to year. (for example, compare the firms listed in Table 4 (from 2000) with those listed in Appendix C (from 1982)) .

Rank	U.S. Firm	Awards (in $Billions)	Japanese Firm	Awards (in $Billions)
1	Lockheed Martin Corp.	$15.1	Mitsubishi Heavy Industries	2.5
2	Boeing Co.	12.0	Mitsubishi Electric Corp.	1.0
3	Raytheon Corp.	6.3	Kawasaki Heavy Industries	0.8
4	General Dynamics Corp.	4.2	Ishikawajima-Harima Heavy Industries	0.4
5	Northrop Grumman Corp.	3.1	NEC	0.4
6	Litton Industries Inc.	2.7	Toshiba Corp.	0.3
7	United Technologies Corp.	2.1	Mitsui Shipbuilding	0.3
8	TRW Inc.	2.0	Komatsu Corp	0.3
9	General Electric Co. Inc.	1.6	Shinmaya Industry	0.3
10	Science Applications International Corp.	1.5	Japan Electronic Calculator	0.2

Table 4. Side-by-Side Comparison of U.S. and Japanese Defense Firms for FY2000

[From: Ref. 38 p. 1 and Ref. 1 p. 1]

The data listed in Table 4 does not imply that the companies therein are the only firms that comprise a defense industrial base for each country. Indeed, there are thousands of smaller prime contractors and subcontractors that regularly contribute to the defense output of each nation. Legislative bodies in both countries favor domestic

production of defense items in a number of regions throughout the country in order to "share the wealth" of government expenditures on defense contracts. However, the top defense firms provide the prime direction for the market and the fates of smaller contractors are often tied to the performance of these top firms. This assertion is supported in both the U.S. and Japan as evidenced by the decade-long consolidation of the defense industries.

The U.S. and Japanese defense industries have a similar market structure. The structure of the two defense industries are driven in large part by the defense polices of their governments and the rules governing the sale of defense equipment. The next section will examine key governmental issues that impact both the USDIB and JDIB.

3. Key Governmental Issues

a. U.S. Government Issues

As noted previously, DoD was preoccupied (during the 1990s) with alternately favoring and discouraging defense industry consolidation. The current defense focus (and Executive Branch interest) has shifted away from the 1990s issue of maintaining a force on limited dollars to reconstituting a force for the global war on terror. While the terrorist attacks on the U. S. of September 11th have resulted in an increased defense budget, it remains to be seen if the increase will result in additional monies for either Research, Development, Test and Evaluation (RDT&E), or Procurement and thus provide more revenue to firms in the USDIB. The full impact of these additional defense expenditures may take several years to have significant impact (if at all). A more immediate concern of the U.S. Government and the USDIB are issues that center around export control policies and the loss of intellectual property as a result of technology transfer.

Export controls by the U.S. Government tend to limit, or at the very least complicate, the sale of defense items to Japan. Export controls do serve a positive purpose in that they provide protection against loss of technology to unauthorized users.

> (However,) business favors looser regulations to enable more extensive cooperative programs with other countries. It is likely that this issue will receive continued attention... [Ref. 8 p. 7].

Export controls are outlined in the Export Administration Act of 1979. In testimony before the House Armed Services Committee, the Assistant Secretary of Commerce for Export Administration (James Jochum) stated:

> For the most part, over the past 23 years U.S. export controls have been authorized under the Export Administration Act of 1979. The 1979 Act has expired on six occasions during that time frame; it most recently expired in August of last year. It has not been re-authorized to date. [Ref. 26 p. 1].

Jochum goes on to testify that the 1979 Act is outdated and must be revised:

> The 1979 Act is a Cold War statute that does not reflect current economic and political realities. The basic national security control authority of this law is predicated on the existence of a multilateral regime - the Coordinating Committee on Multilateral Export Controls - that ended eight years ago. [Ibid p. 2].

Export Controls are a complicated issue that impact defense trade by the U.S. with Japan. However, the U.S. Government is sometimes reluctant to even engage in "allowable" trade with Japan due to issues concerning intellectual property and transfer of technology.

The Report of the 12th Annual U.S. - Japan Technology Forum notes that the "(l)oss of intellectual properties through technology transfer manifests itself in both countries in two ways: (1) the unauthorized leakage of technology to third parties, and (2) the potential policy implications of authorized third party transfers." [Ref. 8 p. 7].

The report goes on to detail the challenge that results as a part of the technology transfer issue. "At the government-to-government level, general agreements are being sought to protect against loss of intellectual properties in the case of third party technology transfers, but participants noted that these are difficult since each transaction usually has several unique factors." [Ibid p. 7]. While the U.S. Government and U.S. firms seem willing to conduct cooperative development and the associated technology transfer, the issue of protection of intellectual property is a major drawback that is yet to be resolved.

Export Controls and protection of intellectual property are two governmental issues that, if adequately resolved, could enhance interaction between the USDIB and the JDIB. In comparison, the JDIB has similar governmental issues to consider.

b. Japanese Government Issues

The Japanese government is also concerned with the issues of export controls and technology transfer primarily as they relate to the restrictions imposed on its defense industry by the "Three Principles." Many in the Japanese government and the Japanese defense industry see the "Three Principles" as an inhibitor of defense trade, but not an insurmountable roadblock.

> Re-evaluation of the "Three Principles" is seen as necessary by many in Japanese industry, but eliminating them altogether is not necessarily viewed as being in the country's best interests. There is growing sentiment in the United States that expanded cooperation can be achieved by retaining but reinterpreting the Three Principles selectively, in accordance with Japanese political sensibilities. [Ibid p. 8].

In essence, the Japanese defense industry's ability to engage in "equitable" technology transfer is restrained by the Three Principles, but the restraints might be relaxed for the U.S., given the proper incentives.

The second key governmental issue that affects the JDIB is also similar to the current U.S environment. This issue is quite simply, money. The Report of the Twelfth Annual U.S.- Japan Technology Forum framed this issue very succinctly:

> Japan's "traditional" defense industry remains constrained by barely increasing procurement budgets and broader controversies surrounding the new Mid-Term Defense Plan (MTDP). Research and development budgets in the new plan imply much more substantial and long-term commitments in the future, particularly as regarding missile defense systems. There are doubts about whether these programs will be able to move forward given these political disagreements regarding funding uncertainty in the future. [Ibid p. 3].

The JDIB faces a fiscally constrained environment that is likely to continue in the short run. This environment further demonstrates that the JDIB is incentivized to interact with the USDIB. The JDIB needs to expand its market base in order to survive and must do so in the face of government restriction. The JDIB must

explore areas that hold growth potential. A potential area for defense industry expansion is entry into markets that have dual-use (i.e. commercial and military use) applications. The next section begins with an examination of potential dual-use markets for the JDIB.

4. Growth Potential

a. JDIB Growth Potential

The growth potential of the JDIB is constrained by both limited fiscal resources and the trade restraints imposed by the three principles. However, both Japanese industry and the Japanese military have made substantial advancements in two dual-use areas. These two areas are Information Technology (IT) and mobile computing.

> Information Technology has already transformed the commercial world. Presumably IT impact in the in the military area will be just as profound. Information security countermeasures have received considerable attention within the industry and the Defense Agency and may be an area in which JDA may lead DoD. Private sector leadership in Japanese initiatives is evident. [Ibid p. 11].

The JDA has made a $190 million investment to provide an integrated computer system for the Self-Defense Forces and a further $38 million is committed to development of an IT system that provides for a common operating environment. Mobile computing (e.g. wireless networks) has the "potential for cooperative programs and distinct implications for interoperability in the future." [Ibid p. 11].

Mobile Computing and IT systems have high dual-use potential, but many industry and government leaders do not see shared military application without problems. "Both areas could run into national security concerns in the process of pursuing both commercial and defense markets." [Ibid p. 11]. DoD and JDA might overcome these security concerns with the proper incentives for both the U.S. and Japan and a demand for advanced technologies . If these concerns are properly addressed, the JDIB has tremendous growth potential in the IT market and related interoperability development with the U.S. However, the JDIB lags behind in a number of defense systems and this represents growth potential for the USDIB.

b. USDIB Growth Potential

The USDIB has growth potential in the U.S. domestic market provided the increase in defense budgets continues and is translated into increases in procurement and other industrial base-related activities. There is also growth potential for the USDIB in the E.U. However, defense markets in the E.U. are increasingly problematic, as E.U. defense firms face declining defense budgets and over capacity. In contrast, there are a number of areas of expansion for the USDIB in the Japanese market.

In comparison to other global defense industries (e.g. the E.U.) the USDIB has a comparative advantage in the Japanese defense market.

> U.S. defense companies, systems, and equipment have excellent reputations in Japan. The Japanese defense industry sees itself as five to ten years behind the United States in systems integration...[Ref. 41 p. 2].

The areas in which the USDIB might expand its market include: missile technology, air defense systems, target acquisition systems, defense electronics avionics, semiconductor components, logistics software, and simulation-related hardware and software. The USDIB can expand into the dual-use markets as well. According to a 1999 report prepared by the Department of Commerce, opportunities exist for U.S. defense firms in the following dual-use markets: telecommunications equipment, medical/diagnostic equipment, aircraft and parts, security and safety equipment, and environmental and pollution control equipment. [Ibid pp. 4-5]. The Japanese defense market has growth potential for the USDIB in both "traditional" defense products and dual-use technologies.

Inhibitors to USDIB growth into this market are the limited Japanese defense budget and the Japanese adherence to "kokusanka" in some defense sectors (e.g. aerospace). These inhibitors may diminish in importance should Japan seek to grow its defense industrial base and realize economies in defense production through strategic partnerships with U.S. firms.

The USDIB exists in a highly-competitive environment while the JDIB exists in a practically non-competitive environment. The USDIB and JDIB have similar market structures with large defense firms (particularly aerospace/missile firms)

obtaining the lion's share of defense dollars in a given year. The USDIB and JDIB face similar governmental issues concerning export policies and concerns about technology transfer. Both Industrial Bases share concerns over the continued level of defense funding, with the JDIB facing the more meager potential revenue stream. Growth potential exists for both the USDIB and the JDIB. This growth potential is inhibited by: the need to address security concerns over IT issues, the limited Japanese defense budget, and the Japanese practice of limiting some sectors of defense production to domestic contractors to maintain autarky. The emphasis on domestic defense production is heavily influenced by the strategic direction of the Japanese Self-Defense Force (JSDF). The next section will analyze the impact of the future direction of the JSDF on the JDIB.

F. FUTURE DIRECTION OF THE JSDF AND IMPLICATIONS FOR THE JDIB

The JDIB has been analyzed, thus far, in reference to its political environment; and in comparison to the USDIB. Next, an examination of the future direction of the JSDF is undertaken in order to assess the impact of the JSDF's direction on the JDIB. The two primary issues that impact the future direction of the JSDF are the recently updated Mid-Term Defense Plan (MTDP) and the emergent role of the Japanese military in international security. This section begins with an examination of the impact of the MTDP.

1. Impact of the MTDP

The MTDP is the primary document that governs the acquisition of new systems for the JSDF. The MTDP is a five-year plan and was updated in 2000 to reflect planned actions for the period 2001-2005. On 15 December 2000, the Japanese government approved a $203 billion five-year procurement plan "for modernizing the Self-Defense forces and dealing more effectively with asymmetric threats in the Asia-Pacific region." [Ref. 8 p. 3]. Table 5 (see pp. 28-29) lists the major programs of the MTDP:

One of the recent additions to the JSDF modernization plan is the effort to modernize and integrate its IT infrastructure. "Major improvements are foreseen in integrating self-defense forces information technology systems, improving the capability to respond to asymmetric threats (such as information warfare, nuclear biological or

chemical attacks), and improved disaster relief." [Ibid p. 3]. The JDA views this IT effort as an enabling component for the JSDF. Section 2.1 of the MTDP entitled "Basic Polices" states that: "In response to the revolutionary advancement of information technology, efforts will be made to establish an advanced network environment throughout the Defense Agency and Self-Defense Forces (SDF), to enhance intelligence as well as command and communication functions and to ensure information security." [Ref. 42 p. 1]. The JDA seems intent on creating an IT infrastructure for its SDF that is both modern and capable of interoperation with U.S forces. This high-priority effort should translate into procurement and R&D contracts for members of the JDIB.

Major Programs, Mid-Term Defense Plan, JFY 2001-05		
Area	***System/Program***	***Units/Five Year Costs****
Ground defense capabilities	Type 90 MBT (Main Battle Tank)	91 Units; $555
	MLRS (Multiple Launch Rocket System)	18 Units; 303
	Armored Vehicle	129 Units; 152
	Transport Helicopter CH-47JA	7 Units; 228
	HAWK improvement kit	0.25 Groups; 152
	New medium range SAM	1.25 Groups; 608
Maritime defense capabilities	Destroyer	5; 4,104
	Guided Missile Destroyer DDG with latest Aegis system	2 units; 608
	Helicopter Destroyer DDH	2; 1,520
	Submarines	5; 1,976
	Anti-submarine helicopter SH-60J	39 units; 1,824
	Airborne mine countermeasures helicopter MH-53E	2 units; 76
Air defense capabilities	F-15 Modernization	12 units; 228
	F-2 Support Fighter	47 units; 3,724

	Transport helicopter CH-47J	12 units; 380
	Tanker transport	4 units; 684
	BADGE system modernization	N/A; 190
IT network	Defense information infrastructure (tri-service computer integration program)	N/A; 190
	Common operating environment	N/A; 38
Research and development	Fixed-wing maritime patrol/ASW P-3C and C-1 transport replacements	N/A; 2,584
	New main battle tank	N/A; 380
	Theater missile defense	N/A; 28 (JFY 2001 only)

Table 5. Major Programs, MTDP Japanese Fiscal Year 2001-2005
[From: Ref. 8 p. 4]

*Values converted to millions of FY$2002

DoD program managers will observe that the potential exists for cooperative efforts between the U.S., the JDIB, and the JSDF in both IT and other programs listed in Table 5. As noted in the report of the 12th U.S. - Japan Technology Forum: "Some programs offer considerable potential for cooperative efforts between the United States and Japan, specifically NTW (Navy Theater Wide Missile Defense) systems and P-3 replacements." [Ref. 8 p. 4].

The degree to which Japan is willing to cooperate with DoD and the USDIB on these programs is not certain. Although Table 5 provides a number of potential venues for co-development and bilateral acquisition projects: "Japanese government officials are quick to assert that no decisions have been made regarding potential cooperative projects (and)...cooperative projects are not necessarily viewed as a net increase in opportunities..." [Ibid p. 4]. Both the Japanese defense industry and the Japanese government remain concerned that projects that promote U.S. - Japan interoperability could result in a loss of either technology or revenue for the JDIB. This concern over loss of revenue and/or intellectual property has the potential to hurt the JSDF in that the JSDF may either lose access to the most advanced (U.S.) technologies or Japanese procurement timelines are extended in order to give Japanese manufacturers time to

develop comparable technologies. However, the primary impediment to the JDA's push for modernization is money.

While significant support exists for expenditures on modernization of the JSDF (as reflected in the MTDP), some in Japanese government wonder: "whether funding levels for specific programs are realistic given the likelihood of rising costs, inflation, and possible program delays." [Ibid p. 3]. The JDA notes that: "Defense-related expenditures for (J)FY2001 total 4.9388 trillion yen (about $36.9 billion) , a 17.1 billion yen (about $127 million) increase over the previous fiscal year (excluding costs for the Special Action Committee on Okinawa (SACO)), but the real growth taking into account price increases and other factors is zero, indicating that defense-related expenditures are still moderate." [Ref. 42 p. 3]. Zero growth of the defense budget, and concerns over inflation, rising costs, and program delays; indicate that the MTDP may be more wishful thinking than program policy. DoD and the USDIB could partner with Japanese defense firms to mitigate some of the current economic concerns. Monetary concerns appear to dominate JSDF and JDIB interaction, however, the JSDF is in the midst of an expansion of its role that could necessitate spending at higher levels.

2. Emergent Role of the JSDF in International Security

The JSDF has received unprecedented support from the Japanese Diet to expand its international role in the wake of the September 11th attacks on the U.S. One of the most significant changes is that the JSDF was recently "authorized to provide support, not only for U.S. forces but also for the forces of other nations participating in the anti-terrorism campaign." [Ref. 42 p. 3]. This authorization marks a departure from the Japanese post-World War II commitment to only engage militarily in direct defense of the Japanese homeland. This JSDF support was manifested in the dispatch of six Japanese Maritime Self-Defense Force (JMSDF) vessels in support of the antiterrorism campaign. "This was the first "wartime" operation outside Japan by the JSDF since its inception in 1954." [Ibid p. 4]. It seems likely that if Japan continues this expanded international role for the JSDF that it must not only modernize, but also increase the size and lethality of its defense forces. The JDIB will undoubtedly benefit from any expansion of the defense forces. The JSDF is also considering enhancing its capability as an autonomous force in the region.

During June 2001, the Japanese Foreign Minister, Maikiko Tanaka "told German Foreign Minister Joschka Fischer that Tokyo's military alliance with the United States is an "easy way" for Japan to enjoy security. But now, she said, "It is necessary for Japan to become more independent in light of its economic power." [Ref. 2 p. 2]. Japan seems to indicate that it is ready to expand its role as a regional power. This intention is strongly supported by the U.S.

> Washington is playing an important role in pushing Japan toward its new role. The Bush administration views Japan as the linchpin to Asian security. If Japan will do more of the heavy lifting of containing an expansionist China, Washington can lower its own profile, the costs of deployments and the exposure of its forces to attack. [Ibid p. 3].

Support among the Japanese leadership and in Washington indicates that the JDIB might enjoy the benefits of a military buildup over the next decade. However, any increase in defense forces still faces stiff internal opposition.

Article IX of Japan's 1947 constitution limits it to a force that has "the smallest necessary defense capability to protect its sovereignty." [Ref. 11 p. 1]. Article IX is further interpreted to imply that Japan may not engage in collective defense when an ally is threatened and some Japanese lawmakers fear that a change to this policy might involve Japan's military in a manner that violates the Japanese constitution. This fear was voiced during the debate over the deployment of JMSDF vessels described in the preceding paragraph. Japanese Prime Minister Koizumi stated the Japanese support of the U.S. anti-terrorism campaign:

> (I)s within the framework of the present Constitution, but just barely. Anything beyond this, and we will have not choice but to deal with it by revising the constitution. [Ibid p. 4].

It seems that the Japanese government may be primed for a serious debate concerning revision of the constitution (and the "Three Principles"?) and subsequently expand the size and composition of the JSDF. Such an action would benefit the JDIB and could potentially benefit the USDIB, if DoD and the USDIB are positioned to capitalize on an expansion of the JSDF.

The future of the JDIB is linked to the uncertain future of the JSDF. While a number of forces exist that favor expansion and modernization of the JDIB (e.g. MTDP modernization effort and the expanded role of the JMSDF), it is unclear whether these forces will result in higher defense budgets and more defense contracts for the JDIB. It is evident that the U.S. favors an expanded role for the JSDF in both regional and international military roles and the JDIB (and USDIB) may directly benefit from the U.S. push for a stronger Japanese military.

G. SUMMARY

The end of the cold war marked a transition point for the JDIB and 1991 saw the last substantial hike in defense spending. The JDIB has survived despite restrictions on arms exports known as the "Three Principles". The JDIB has survived primarily through a Japanese policy of "kokusanka" which favors internal production of defense items even when production of those items results in products that are of lower quality and more costly than comparable. U.S. products. When domestic production is not possible, the JDIB (and Japanese government) has engaged the U.S. in cooperative development programs and JDIB firms produce a number of U.S. defense items under licensed production and co-production agreements.

The JDIB is a small industry and about 12 firms account for most of Japanese defense contracts in a given year. The JDIB is essentially a non-competitive market that exists in an era of fiscal austerity and zero growth. In contrast, the USDIB is a highly-competitive market and has recently seen an increase in defense-related expenditures. Despite these contrasts, the JDIB and USDIB share a number of similarities. The USDIB is similar to the JDIB in that: (a) it is also dominated by several large companies at the top of the defense industry; (b) the USDIB and JDIB share concerns over export controls and protection of intellectual property rights and; (c) growth potential exists in both markets, particularly in dual-use technologies.

The JDIB is almost wholly dependent on the JSDF for its defense revenues. The JSDF faces an uncertain future and this uncertainty weighs heavily on the future of the JDIB. The MTDP and emerging international roles for the JSDF indicate the possibility of positive growth for the industry; however, these forces are counterbalanced by

domestic economic uncertainty and a fear that Japan may become unnecessarily entangled in international military actions.

The ability of the JSDF and JDIB to effectively address emerging defense issues will almost certainly depend on effective interaction with DoD and the USDIB. Emerging defense issues are likely to include U.S. - Japan interaction in the area of defense acquisition. The U.S. - Japan acquisition environment is defined by past and on-going acquisition interfaces. The next chapter examines three U.S. - Japan acquisition interfaces.

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III. ANALYSIS OF THE US-JAPAN ACQUISITION ENVIRONMENT

A. INTRODUCTION

To effectively identify future acquisition opportunities for DoD, it is necessary to define the current U.S-Japan acquisition environment. The current U.S. - Japan acquisition environment can be defined through an examination of selected U.S. - Japan acquisition interfaces. In this chapter, the U.S. - Japan acquisition environment is defined through an analysis of three U.S. - Japan acquisition interfaces. These three interfaces are: cooperative development of the Mitsubishi FS-X (F-2) Support Fighter, Foreign Military Sales co-production of the Aegis Anti-Air Warfare radar system, and cooperative development of a Theater Missile Defense system.

The three interfaces are presented as modified case studies that focus on economic the factors present in each interface. These modified case studies provide the basis for identification and evaluation of economic factors present in the U.S. - Japan acquisition environment. This analysis of the U.S. - Japan acquisition environment begins with an analysis of the most expensive and controversial U.S. - Japan acquisition project to date, the Mitsubishi F-2 Support Fighter.

B. FS-X (F-2)

1. Background

In the early 1980s, the JDA began to develop a replacement for its F-1 ground attack aircraft. DoD was initially interested in providing a U.S. aircraft as a replacement for the Japanese F-1. JDA resisted attempts by DoD to proffer a U.S.-designed aircraft as a replacement. The JDA viewed indigenous development of a replacement aircraft as beneficial in two areas: (1) autonomy in the Japanese acquisition process and (2) development of the Japanese aerospace industry. The JDA assessment was that Japan would receive a greater marginal benefit from autonomous development that it would otherwise receive from co-development with the U.S.

During the summer of 1985, DoD began a concentrated effort to convince Japan of the need for co-development of the FS-X. The incentive for DoD to push for co-

development was Congressional concern over the growing trade deficit with Japan. The FS-X program was seen as a vehicle to facilitate the export of U.S. aerospace products. In 1988, a Memorandum of Understanding (MOU) was concluded between the U.S. and Japan. The MOU called for Japan to undertake cooperative development of the new Japanese fighter with the U.S. The FS-X was to be based upon the existing U.S. F-16 airframe.

The MOU was submitted to Congress in 1989 for approval. Congress favored the sale of F-16 technology to the extent that it provided for more production of F-16 components in the U.S. However, Congressional critics of the MOU were concerned that, in terms of technology transfer, the FS-X project "represented a giveaway of advanced aerospace technology to America's most relentless economic rival, with few guarantees of anything significant in return" [Ref. 28 p. 2]. The concern over technology transfer issues resulted in a significant amendment to the original MOU that caused both anger and frustration in Japan.

The revised MOU asserted that the U.S. would provide a disproportionate amount of aerospace technology in the co-development process. Based upon this assertion, the new MOU designated most FS-X technologies as derivatives of existing F-16 technology. Therefore, Japanese defense firms would be required to automatically provide any Japanese developments to the U.S. at no cost. This process was labeled as "flowback" of technology and was strongly resented in Japan. The resentment in Japan was founded upon two key issues: (1) Japan had essentially been "bullied" into a co-development agreement and (2) once the agreement was signed, the U.S. amended the agreement to make Japan a minor player in its own development program. Despite Japanese resentment, the project moved forward and the first co-developed and co-produced aircraft was delivered to the JASDF in 2000. A timeline of major FS-X events for 1985-2000 is provided at Table 6 (see next page).

Lockheed Martin was awarded the joint production contract for the F-2 in 1996. Lockheed has been pleased with its partnership with MHI. Lockheed's F-2 Program Director, Don Jones, stated: "Lockheed Martin has had an outstanding relationship with MHI and with the JDA during the development phase of the F-2 and we look forward to

continuing that relationship as we enter into production." [Ref. 40 p. 3]. The two firms have also engaged in mutually beneficial technology transfer. One of the most notable achievements was the transfer of unique cocuring methods developed by Japanese industry and used by Lockheed in the production of wing components for the F-2 [Ibid p. 3]. The F-2 is currently in production despite the difficulties it encountered during the development process. However, most of the difficulties in program production were due to problems caused by the U.S. Government (vice industry).

Year	Event
1985	Japan tentatively approves national fighter program
1986	U. S. Proposes Joint modification of U.S. fighter
1987	Japan accepts joint modification of F-16C
1988	Research and Development MOU signed
1989	License and Technology Agreement signed Side letters added from both U.S. and Japan Implementing Arrangement drafted
1990	Research and Development begins Memorandum of Implementation and Agreement signed
1992	Technology Transfer Procedures Annex added to base agreement
Oct 1995	First Flight of production prototype F-2
1996	130 F-2s approved for procurement/production by Japanese government
Sep 1996	Lockheed Martin awarded joint production contract with MHI
Oct 2000	MHI delivers first F-2 to JASDF

Table 6. FS-X/F-2 Events Timeline
[From: Ref. 30 p. 4]

2. Analysis of the FS-X Program

In Dr. Mark Lorell's book on the FS-X, he identifies five problem areas in the FS-X development project:

> 1. The U.S. Government did not formulate and implement a single coordinated strategy with Japan that harmonized both U.S. military and economic objectives.
>
> 2. The American side pressured the Japanese political leadership to accept a type of cooperative development program that was strongly opposed by the Japanese military R&D establishment.
>
> 3. The FS-X program should have been structured to provide greater U.S. influence over the final design configuration and technological evolution of the aircraft.
>
> 4. The U.S. Government underestimated Japan's military R&D capabilities.
>
> 5. U.S. policy on technology transfer and access was fundamentally flawed. [Ref. 43 pp. 5-6].

The researcher selected three of Lorell's problems for further analysis in the context of economic opportunities for DoD. The first problem to analyze is the disharmony of U.S. military and economic objectives in the FS-X program.

a. The Absence of a Single U.S. Strategy for the FS-X

The U.S. military's objective for the FS-X program was relatively simple; DoD wanted to prevent Japan from developing a completely indigenous advanced fighter aircraft. Congress, on the other hand, was very concerned that any co-development project with Japan would result in a disproportionate transfer of aerospace technology to Japan. Lorell notes that: "(I)t is a great irony that DoD's apparent success in achieving its most important objective - stopping indigenous development by winning Japanese acceptance of an FS-X based on the F-16/Agile Falcon design - ultimately served to provoke the explosion of criticism from Congress against the FS-X agreement" [Ref. 30 p. 207]. Congress viewed the FS-X agreement as nothing more than a poor decision to give advanced aerospace technology to the U.S.' chief economic competitor. DoD

wanted to allow Japan access to the technology to prevent them from developing a new military capability; Congress feared that giving Japan access to technology would give them an economic advantage in future aerospace development. Two U.S. entities created conflicting objectives in the same program.

In contrast, Japanese Government and industry leaders united behind a single goal - development of an indigenous Japanese fighter. Japanese Government and industry leaders knew (early on) that the U.S. could exert enough political pressure to force Japan into a co-development agreement. Japanese negotiators decided to accept co-development (based on an F-16 airframe) and then negotiate "a program structure that provided latitude to transform the collaborative FS-X as much as possible into (an) indigenous Japanese fighter." [Ref. 28 p. 2]. The Japanese recognized that fusion of military, national, and economic objectives in this program was essential to attainment of the desired goal.

The FS-X program indicates that DoD Program Managers should work with interested parties (in both industry and government) to identify and evaluate the economic issues present in any project that involves international collaboration. These economic issues must be incorporated into program goals and should represent a careful integration of strategic security concerns, acquisition objectives (e.g. minimize cost, minimize schedule risk, and maximize performance), and international defense industry synergies. In the FS-X case, integration of DoD and Congressional objectives might have resulted in a more mutually beneficial program in terms of both technology development and overall economic benefit.

b. Underestimating Japanese R&D Capabilities

Japan views its aerospace industry as an integral player in its overall industrial and technological base. Japanese industry and government view investment in aerospace R&D as a multi-faceted activity that is value-added to a wide range of military and commercial applications. Firms in the JDIB view spin-off (military to commercial applications) and spin-on (commercial to military applications) technologies as ends in themselves. Japanese industry leaders created a metaphor for aerospace as a strategic industry. The metaphor was a tree with "the industry as the trunk of a tree with roots in

the key basic technologies and fruits in every variety of industrial and consumer product line.[3]" [Ref. 44 p. 245]. In the FS-X project, the U.S. failed to recognize that Japan viewed their R&D investment as broadly applicable to both military and commercial sectors and not just applicable to development of an indigenous fighter. This failure to adequately appreciate Japanese dedication to aerospace R&D caused the U.S. to severely underestimate their R&D capabilities.

The U.S. also felt that Japan had nothing to offer in military aerospace R&D. Lorell notes that:

> With respect to military R&D, most American experts in government and industry believed Japan had little to offer the United States. When a DoD technical team visiting Japan in 1984 discovered that the Japanese were developing a radically new type of fire-control radar for (the FS-X), the information apparently languished at the Pentagon until much later, when technology access became a hot political issue during the height of the FS-X controversy in Congress. [Ref. 30 p. 10].

The Pentagon virtually ignored the potential value of any Japanese military aerospace R&D efforts and unwittingly contributed to Congress' view that the FS-X project was simply transferring valuable U.S. aerospace technology to Japan. Had DoD more readily recognized that valuable Japanese technology was in development, it might have more effectively made its case in Congress for co-development.

The economic lesson for DoD Program Managers is that Japan has a credible R&D program for military applications and it treats its R&D capability as a priority. Japan is viable source for collaborative R&D in a number of defense-related areas. The opportunity for collaborative R&D is particularly valuable in the current environment of fiscally-constrained defense budgets. Table 7 (see next page) provides an overview of JDA expenditures on R&D for the period 1991-2002.

Table 7 (see next page) indicates that: (1) Japan's R&D expenditures are relatively small and (2) Japan will try to increase R&D expenditures despite an economic downturn and virtually zero-growth defense budgets. These two factors create an environment where DoD might leverage Japanese dedication to R&D to assist in

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[3] A graphical representation of this tree is provided at Appendix D.

development of advanced defense technologies. This type of cooperation is not limited to government-to-government interaction. MHI and Boeing Corporation have jointly developed a new rocket engine for commercial application. The two companies invested over $10 million to develop the engine and the project was 100 percent commercially-funded. [Ref. 3 p. 1 and Ref 4 p. 1]. Government-to-government and/or industry-to-industry collaboration with Japan in R&D might help to mitigate program risks and potentially add to the customer base for products that flow from the R&D efforts.

JFY	JDA Budget	Procurement (in $billion at Y120=$1	R&D	Budget Ratios Procurement	R&D
1991	36.55	10.14	.86	27.7	2.3
1992	37.93	9.52	.96	25.1	2.5
1993	38.67	8.99	1.03	23.3	2.7
1994	39.03	8.32	1.05	21.3	2.7
1995	39.36	7.25	1.16	18.4	3.0
1996	40.38	7.63	1.25	18.9	3.1
1997*	41.18	7.79	1.34	18.9	3.2
1998*	41.08	7.87	1.06	19.2	2.6
1999*	41.00	8.02	1.09	19.5	2.6
2000*	41.02	7.78	1.12	19.0	2.7
2001*	41.16	7.86	1.19	19.0	3.0
2002*	41.16	7.80	1.30	19.0	3.0

Table 7. JDA Procurement and R&D Expenditures 1991-2002
[From: Ref. 34 p. 1]
*Does not include additional expenditures for special Okinawa base measures

c. U.S. Policy on Technology Transfer

The fundamental flaw in U.S. policy on technology transfer in the FS-X program was the U.S.' unfounded concern that the transfer of the F-16 Technical Data Package (TDP) would result in selling "Japan the blueprints for making one of the world's best tactical fighters for a mere $60 million." [Ref. 30 p. 359]. The concern that the U.S. was giving away critical aerospace technology resulted in friction throughout the program. As a result of this friction, and unprecedented scrutiny of each transfer event, the TDP was delivered behind schedule and in a piecemeal manner.

> This situation clearly displeased the Japanese...To many Japanese, access to U.S. technology appeared to be increasingly restricted and circumscribed. Furthermore, Japan had to pay for everything it got (and had to provide "flowback" of derived technologies at no cost). And to add insult to injury, the Americans were taking nearly a year to transfer the data package, the exact content of which would not be known by the Japanese until the end of the procedure (thus stalling the start of the Japanese R&D effort). [Ibid p. 271].

The U.S. policy on technology transfer essentially hobbled a program that the Japanese had wanted to conduct indigenously and U.S. demands for free flowback further eroded any potential Japanese proprietary technological gains (one of the main reasons Japan had wanted to develop the FS-X indigenously).

U.S. concerns over technology transfer were overblown. A 1992 GAO report found that, not only had control of technology transfer been adequate, it may have been "too strict" [Ibid p. 361]. The end result of this policy was to obviate the U.S.' primary goal in the co-development program. "It seems certain that the U.S. denial of rights for licensed production of certain components and technologies in Japan during the FS-X R&D phase has encouraged even greater indigenous development by Japanese industry" [Ibid p. 361]. The technology transfer issue contributed to undermining the U.S. goals for the program, and this issue was clearly avoidable.

A key issue in technology transfer is how to value technology and intellectual property. Technology could be treated as a marketable good if it were given a value that is determined by its marginal benefit to each side. When the transfer of technology is involved in an international collaboration, the cost of allowing access to the

technology must be included in the program cost. In the FS-X case, the agreed-upon cost of the F-16 TDP should have reflected both the cost of access to the technology and the (U.S.) benefit of preventing development of an indigenous Japanese fighter. Congress did not identify direct parity in FS-X technology transfer and therefore saw no real marginal benefit to the U.S. However, the real marginal benefit of the technology transfer was prevention of indigenous fighter development by Japan.

In sharing technology and intellectual property, the U.S. must also consider how sharing its technology will contribute to security alliances and commonality/interoperability of systems. While there may be a rationale for retaining the rights to certain technologies, this retention of knowledge must be weighed against the cost to the combined R&D effort. The FS-X case seems to indicate that flowback technologies were perceived as having some marginal benefit to the U.S. In future acquisition projects, a requirement to provide flowback of technology at no cost to the receiving country could create an asymmetry in the technology transfer market and disincentivize program participation. The economic lesson is that a mutually agreed upon value must be assigned to transferred technology, otherwise the costs of participation in a co-development program, like the FS-X, become so high that any (real or perceived) benefits are lost.

3. Lessons of the FS-X Program

The FS-X program can be classified as a successful program because, in the end, it delivered a high performance aircraft to the JASDF that is a significant improvement over the F-1. However, the road to success was longer and bumpier than necessary. The key lessons from the FS-X are: Congress and DoD must have unified objectives and these objectives must incorporate economic concerns; (2) Japan considers R&D important and can have significant technological contributions to a cooperative program and; (3) in technologically intense programs, like the FS-X, technology transfer issues must be addressed from an economic perspective. In the next section, the highly successful collaboration effort on the Aegis Foreign Military Sales Program is presented as a contrast to U.S. - Japan experience with the FS-X.

C. AEGIS FOREIGN MILITARY SALES (FMS) CO-PRODUCTION PROGRAM

1. Background

The Aegis system is a ship-borne combat system that has, as its centerpiece, a phased array radar that "can automatically track multiple targets simultaneously while maintaining surveillance of the surrounding airspace." [Ref. 48 p. 1]. Although Aegis is a complete combat system, Japan purchased only the Anti-Air Warfare system and some combat system elements. The Aegis system itself is actually installed by Japanese shipbuilders. The U.S. Navy's (USN's) Program Manager, Ship 400 (PMS 400) office has overall responsibility for the program and Lockheed-Martin is the prime U.S. contractor. Japanese firms involved in the program include: MHI, IHI, Hitachi, and MELCO. The first Aegis equipped ship, JDS Kongo, "was commissioned on March 25, 1993, with all USN-supplied systems operational. Both JMSDF and the shipyard were very pleased" [Ibid p. 4]. In May 2002, DoD began the sale of a fifth Aegis system to Japan. The Aegis system encountered problems similar to the FS-X concerning technology transfer, however, these problems were handled quite differently.

2. Congressional Concerns

At the inception of the Aegis FMS program in 1988, Congress was concerned the Japan might reverse engineer the Aegis system and initiate indigenous production. As a result of Congressional concerns, additional restrictions were placed on the sale that discouraged reverse engineering of the system. Congress also wanted Japan to buy a total Aegis ship and not just the AAW system. This option was strongly favored by the U.S. shipbuilding industry. However the purchase of a complete ship by Japan seemed highly unlikely.

Several factors weighed in favor of an "Aegis AAW only" deal: (1) an earlier ship-borne AAW system (TARTAR) was previously sold to Japan as a separate system (i.e. an established precedent), (2) Japan needed the ship construction contracts for its depressed ship-building industry, (3) the Japanese ship would contain a number of Japanese-derived systems (because the equivalent U.S. systems were not eligible for release under FMS), and it was estimated that:

one Aegis (AAW system) for Japan will result in 5,400 man-years of U.S. labor and that U.S.-built Aegis-capable hulls would bring 2,700 more. Thus, for every ship-building job we (Congress) insist on, we risk losing two jobs in the electronics industry. [Ref. 46 p. 2].

These four factors combined to make it highly unlikely that Japan would buy a complete U.S. ship or that Congress would insist on a complete ship buy. Congress eventually relented and an MOU was approved for the program. Unlike the FS-X, the overall benefit of the sale of the system outweighed concerns over technology transfer. However, technology transfer did become an issue later in the Aegis program.

3. Procedures for Technology Transfer

Lockheed-Martin opened an office in MHI's Nagasaki shipyard in 1989, shortly after problems began to develop over technology transfer and releasability policies. Lockheed-Martin, PMS 400, JMSDF, and the Japanese contractors quickly developed detailed technology transfer guidelines to address concerns on both sides. These concerns were addressed through implementation of four guidelines:

> (1) All drawings, ship interface criteria and test procedures got through formal Navy-to-Navy channels; (2) a liaison information transfer report (LITR) procedure (was) established for Lockheed Martin to directly answer MHI's questions on data formally transferred; (3) nonreleasable data may not be transferred by LITR; and (4) copies of LITRs are sent to PMS 400 a the same time they are sent to Japan. [Ref. 19 p. 4].

These procedures enabled efficient transfer of technical data. The key feature of this design is that the guidelines were written to allow timely industry-to-industry interaction where possible while simultaneously keeping oversight agencies aware of on-going activity. These procedures have allowed the Aegis FMS program to proceed smoothly and the program has provided benefits to the both the U.S. and Japan.

4. Benefits of Aegis

The Aegis program has accounted for over $2 billion in FMS to the U.S. and Japan has shared in the developmental costs of the system. The overall cost of production of the system has been reduced as economies of scale are realized through larger production quantities (Japan also pays a fair share of common overhead costs).

U.S. Navy officials testified before Congress that the U.S. would benefit from "a potential reduction in the number of ships the USN would have to deploy in the Western Pacific as Japan increased its capability with Aegis." [Ibid p. 7]. Lockheed-Martin benefited from the program through the training of a "large group of U.S. engineers and managers in an international environment." [Ibid p. 6]. The JMSDF continues to benefit from the program by having an advanced AAW capability on its warships. Both the U.S. and Japan have benefited through greater interoperability and commonality of systems.

5. Economic Factors in the Aegis Program

The key economic factors in the Aegis program were the economies of scale realized through expanded production and sharing of common overhead costs. The Lockheed-Martin interface with Japanese shipbuilders has also provided a potential economic benefit to the USDIB by enabling more proficient participation in international programs. A form of cost-benefit analysis was conducted (by Congress) concerning the potential lost revenues from failure to sell the program as a complete ship vice just a radar system. This analysis concluded that the benefits from the sale of just the AAW system outweighed the potential for lost revenues due to not selling Japan a complete ship. The Aegis program is an example of a successful collaborative effort between the U.S. and Japan. In the next section, another successful collaborative effort is examined, U.S. - Japan cooperation on Theater Missile Defense.

D. THEATER MISSILE DEFENSE

1. Background

In the 1980s DoD conducted "a preliminary study of missile defense requirements in the Western Pacific." [Ref. 17 p. 1]. A U.S. - Japan Theater Missile Defense (TMD) working group was created in 1993 "to provide a forum for regular discussion of TMD.... On August 31, 1998, North Korea launched a *Taepodong* three-stage missile over the Japanese archipelago." [Ibid p. 2]. The 1998 North Korean missile launch provided impetus to the missile program, which had languished since the establishment of the working group in 1993 and :

> (i)n 1999, the US and Japan signed a three-year MOU on Cooperative Ballistic Missile Research. The focus of this project has been joint research on four component technology areas (second stage booster,

lightweight nose cone, IR sensor, and kinetic warhead) to be integrated into the SM-3 missile[4] as part of the Navy Theater Wide Defense System. [Ref. 37 p. 1].

The overall TMD system consists of a complex interface of space-based, sea-based, and land-based sensors, weapons, command, control, computer, communications, and intelligence systems. The U.S. - Japan TMD research effort is currently focused on mid-course intercept of ballistic missiles using sea-based systems (the Aegis radar is one component of the sensor system). Requirements analyses for this stage of the program were scheduled for completion in June 2002[5]. Lockheed Martin and Raytheon are the prime U.S. contractors for the system. MHI is the lead firm in a consortium of Japanese defense companies that includes: MELCO, KHI, Toshiba, Fujitsu, and IHI. The TMD program has brought both benefits and challenges.

2. Economic Benefits of TMD

Through participation in the TMD, Japan benefits from the U.S.' long-term commitment to research in missile defense. Japan's acquisition of the Aegis radar system has helped to quickly integrate Japan in the current Sea-based Mid-Course Defense initiative. Japan enjoys the use of certain U.S. test facilities as a result of the program. The Japanese have contributed significantly to technological advancement of the project by providing advance technologies that contribute weight reduction (e.g. composite materials, and miniaturized components) and radar technologies applicable to upper-tier (i.e. mid-course) systems. [Ibid p. 1].

3. Economic Challenges in TMD

Economic challenges in the TMD program have centered on differences in acquisition and contracting procedures. The specific challenges have been:

(a) The Japanese R&D contract is funded for multiple years whereas the U.S. contract covers only one year,

[4] The Standard Missile-3 (SM-3) is designed solely for TBM defense and operates above the Earth's atmosphere to intercept medium and long-range tactical ballistic missiles [Ref 37 and Ref 39 p. 4]. The SM is the Navy's principle Surface-to-Air Missile and has undergone numerous pre-planned product improvements. [Ref. 39]. See also Appendix B.

[5] Results of this analysis were not available prior to publication of this thesis

(b) JDA's contract with MHI is a Firm-Fixed Price contract whereas the U.S. contractors enjoy the benefit of a Cost-Plus type contract,

(c) JDA's contract defines detailed requirements for the R&D phase while the DoD contract only defines top-level requirements. [Ref. 31 p. 18].

These challenges have been overcome primarily due to both countries dedication to the project. However, the Bush administration plans to accelerate deployment of the sea-based system. Given this accelerated schedule it may be difficult for a financially-strapped JDA to continue as a full partner in development.

4. Economic Factors in TMD

A key economic factor in TMD (thus far) has been the economic risk reduction that was achieved through sharing the costs of the R&D effort. The U.S.' FY 2002 defense budget allocates $3.3 billion to TMD over the next five years. Japan will spend $53.1 million in the R&D effort on TMD in JFY 2002 [Ref. 37 p. 2]. Future economic factors that may apply to TMD are: economies of scale in sensor and missile production, spin-off technologies as a result of advanced command and control systems, and additional interoperability benefits thorough increased reliance on common communication systems.

E. CHAPTER SUMMARY

This chapter characterized the U.S. - Japan acquisition environment through identification of key economic factors present in the FS-X/F-2 cooperative development program, the Aegis FMS cooperative production program, and the cooperative R&D effort in TMD. Key economic factors that were:

(1) DoD program managers must identify and evaluate the economic issues present in any project that involves international collaboration. These macroeconomic issues must be incorporated into program goals and should represent a careful integration of strategic security goals, acquisition objectives (e.g. minimize cost, minimize schedule risk and, maximize performance) and international defense industry synergies.

(2) Technology transfer and intellectual property issues must be resolved through economic valuation of the technology as defined by the marginal benefit of the

technology transfer to the overall program. A mutually agreed upon value must be assigned to transferred technology, otherwise, the costs of participation in a co-development program may become so high that any (real or perceived) benefits are lost.

(3) Cooperative production arrangements with Japan create economies of scale through expanded production and sharing of common overhead costs.

(4) Government-to-government and/or industry-to-industry collaboration in R&D might help to mitigate program risks and potentially add to the customer base for products that flow from the R&D effort. A robust, collaborative R&D effort with Japan may also yield economic benefits in the form of commercial spin-off technologies and alliance synergies through fielding of interoperable defense systems.

The U.S. - Japan acquisition environment provides a number of opportunities for synergies in acquisition of defense systems. To effectively capture potential acquisition synergies, specific acquisition projects must be identified and evaluated. Chapter IV outlines a methodology for identifying acquisition opportunities, and identifies acquisition opportunities for DoD in: specific defense systems, general defense areas, and acquisition policy development.

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IV. ACQUISITION OPPORTUNITIES FOR DOD

A. INTRODUCTION

An acquisition opportunity for DoD within the JDIB is defined as any opportunity for DoD to achieve best-value in its systems acquisition process through collaboration with Japan. An examination of Japanese and U.S. acquisition plans identifies three specific, and three general, acquisition opportunities for DoD. In addition to identification, acquisition opportunities may require further evaluation to determine: (a) which opportunities to pursue and (b) what form of collaboration is optimal for a specific bilateral acquisition opportunity. The researcher presents a tool for evaluation of acquisition opportunities and uses the tool to retroactively evaluate the FS-X project. (Alternative methods for assessment of acquisition opportunities are also provided.) In addition to the factors considered in the tool, acquisition opportunities are framed by DoD acquisition policy. Some elements of DoD policy present hurdles to collaborative projects and four of these hurdles are examined. The first step in identification of acquisition opportunities is to identify any synergies between Japanese and U.S. acquisition plans.

B. IDENTIFICATION OF SYNERGIES BETWEEN JAPANESE AND U.S ACQUISITION PLANS

Japanese Acquisition Plans include recapitalization of the current force structure. Japan's current Mid-Term Defense Plan calls for R&D investment in replacements for: (a) the current Anti-Submarine Warfare aircraft, (b) the current transport aircraft, (c) and the Main Battle Tank, in addition to (d) further development of Theater Missile Defense [Ref. 8 p. 4]. U.S. acquisition plans include three potential areas for bilateral synergy in the acquisition effort. These areas are: (a) replacement of the current U.S. Anti-Submarine Warfare aircraft (P-3C), (b) component development of mission systems in cargo aircraft, and (c) continued investment in Theater Missile Defense [Ref. 36 pp. 2-3]. Each of these acquisition efforts is outlined below. In addition to these three specific areas, less well-defined opportunities for bilateral cooperation are also presented.

1. Patrol Craft Experimental (P-X) and the Multi-mission Maritime Aircraft (MMA)

The U.S. and Japan both use the P-3C family of aircraft to conduct airborne Anti-Submarine Warfare. Both nations also plan to replace these aging, propeller-driven, aircraft with an updated jet-powered version. The Japanese effort is known as the Patrol Craft Experimental (P-X) and the U.S. effort is known as the Multi-Mission Maritime Aircraft (MMA). The U.S. and Japan have similar development timelines with Japan planning for Initial Operational Capability (IOC) in 2010 for the P-X and IOC for the MMA projected for 2010-2012. The P-X and MMA would appear to offer significant opportunities for bilateral collaboration with Japan; however, difficulties have already arisen.

Japanese officials tend to favor an indigenous development program for the P-X (i.e. the basic desire for kokusanka, especially in aerospace). However, there is "wide-spread skepticism among U.S. Government and industry officials over whether the JDA can really support indigenous efforts on (the) P-X." [Ref. 35 p. 1]. The report of the 13th Annual U.S. Japan Technology Forum noted that: "$265 million is being spent on next generation maritime patrol and transport aircraft, out of a total development budget of $2.6 billion - a figure that some U.S. participants questioned as unrealistically low." [Ref. 7 p. 13].

Japan's apparent lack of fiscal resources may inhibit indigenous development of the P-X aircraft. This fiscal constraint may serve as the primary catalyst for greater bilateral cooperation. Japan has shown a great deal of interest in cooperation concerning the MMA and is associated systems. "U.S. - Japan interface on future MMA systems has been unprecedented in (the) beginning, from consideration of basic requirements, and progressing through concept exploration toward system development" (a degree of interaction that never occurred in the case of the FS-X). [Ref. 35 p. 1-2]. Japan plans to dovetail its P-X development program with its plan for replacement of its primary cargo aircraft, the C-1.

2. Cargo Aircraft Experimental (C-X) and the MMA

The JDA plans to replace its aging fleet of indigenously developed C-1 cargo aircraft with an updated cargo aircraft. The C-1 is a "twin-engine, turbofan, medium size, medium-range troop and cargo transport aircraft." [Ref. 23 p. 1]. The new cargo aircraft is called the Cargo Aircraft Experimental (C-X). A Request for Proposals (RFP) was issued by JDA in May 2001. "Foreign proposals for the C-X included Airbus A310, Boeing C-17, and Lockheed Martin C-130J, but Kawasaki (Heavy Industries Limited was) selected by JDA in November, 2001, to lead development of an indigenous design to meet both C-X and (P-X) requirements, with (an) optimum degree of structural commonality." [Ref. 24 p. 1]. C-X program objectives include: a twin-turbofan power plant, increased range, and a payload capacity approximately double that of the Lockheed-Martin C-130J (the C-130 is also in service with the JDA). "(D)esign parameters include high-mounted wing, rear-loading ramp/door, digital AFCS (Automatic Flight Control System) and 'glass cockpit' avionics; outer wing, flight deck, and tail unit (will) be common with (the P-X)." [Ibid p. 1]

The JDA has devoted $2.6 billion for the development of both the C-X and the P-X. Exact specifications for the new aircraft have not been published. However, U.S. concerns about the C-X are similar to those expressed over the P-X development program. DoD is doubtful that JDA possesses the fiscal resources to undertake a full indigenous aircraft development program. The Boeing C-17 Globemaster-II was originally proposed as a replacement for the C-1. Although the Boeing aircraft was rejected, Japanese requirements for a digital AFCS and "glass cockpit" may later develop into co-production or FMS-licensed production of similar U.S. components (e.g. C-17 or MMA mission systems).

3. Theater Missile Defense

Chapter III outlined a number of key benefits of TMD for both the U.S. and Japan. The Report of the 13th Annual U.S. Japan Technology Forum noted that: "the most important benefit of (bilateral cooperation in missile defense) is mutual exchange of beneficial technologies and a synergy between respective engineering capabilities. The division of labor agreed upon by Boeing and MHI in the case of the MB-XX is consistent

with this viewpoint." [Ref. 7 p. 8]. Japanese firms are currently working on development of SM-3 missile that will serve as the intercept vehicle in the Sea-based Mid-Course Defense portion of the TMD system. Thus, a JDIB product is a key component of the overall system.

The Technology Forum noted that U.S. - Japan cooperation seems very likely to continue as both countries are committed to development of a missile defense system. TMD involves advanced technology development in the field of aerospace and aerospace is an area in which Japan has shown historical interest in collaborative programs. TMD collaboration will most likely increase, as more government-to-government and industry-to-industry relationships are formalized to facilitate development process. JDA's fiscal problems will incentivize Japan to conduct collaborative TMD R&D with the U.S. TMD could be a fully integrated, collaborative effort with Japan. Japan's future level of participation in this program will most likely hinge on its ability to continue to contribute to the program (vis-à-vis constrained fiscal resources) and a continued commitment by the U.S. to field an interoperable system.

4. Other Potential Areas for Bilateral Cooperation

This section has described three specific areas for bilateral cooperation that all fall within the defense aerospace industry. The researcher selected the P-X, C-X, and TMD for exposition because these projects had clearly defined, common, requirements. Other areas for acquisition synergies exist, albeit in less well-defined forms:

-JDA is leading an effort in the creation of Advanced Information and Communication networks. This area includes tentative, bilateral, efforts in cyber security and biometric identification. Efforts in the area will contribute to security of both military and non-military related IT resources.

-MELCO is conducting development of a scalable, distributed simulation system. This system includes plans for a High Level Architecture/Run-Time Infrastructure (HLA/RTI) similar to a concept of HLA outlined in the DoD Modeling and Simulation Master Plan (DOD Directive 5000.59) published in January, 1994. This system would enable worldwide, real-time, simulations and facilitate the modeling of interoperable systems.

-FHI is leading an effort that examines dual-use application of rotary-wing unmanned aerial vehicles. [Ref. 7 pp. 2-10]. FHI already has a prototype model in use for spraying of agricultural pesticides.

These areas are (potentially) of interest to both the U.S. and Japan. A driving factor in bilateral development of these areas is the strong potential for advanced technology development. Japanese firms are particularly interested in those areas with dual-use applications. The acquisition opportunities in these areas are not currently tied to a specific DoD acquisition project and were therefore not selected for analysis. Interested readers may contact the Center for U.S. - Japan Studies and Cooperation, Vanderbilt University Institute for Business and Public Policy, Nashville, Tennessee, for additional information and updates in these areas.

B. AN ASSESSMENT TOOL FOR EVALUATION OF ACQUISITION OPPORTUNITIES

The preceding section outlined three specific projects wherein the U.S. and Japan might benefit from bilateral cooperation in defense acquisition. However, the researcher was unable to find an existing assessment tool or methodology that would effectively assist DoD Program Managers in answering two basic collaboration questions: (1) which acquisition opportunities should DoD pursue and (2) what is the optimum type of collaboration for a specific bilateral acquisition opportunity. In this section the researcher presents an assessment tool that is designed to help Program Managers answer these two basic questions.

This tool was developed using by Dr. Mark Lorell's "Pros and Cons of Collaborative Programs"[6] as a point of departure. The subjective assessments in Dr. Lorell's model were used to develop detailed objectives for collaborative acquisition projects and subsequent evaluation of those objectives using an additive utility function as described in Robert T. Clemen's <u>Making Hard Decisions</u> [Ref. 9 pp. 536-560]. Use of the additive utility function in assessing the costs and benefits of acquisition projects with Japan will allow the Program Manager to rationally assign ordinal values to the comparison of acquisition alternatives. A basic template of this tool is provided at

[6] Dr. Lorell's model is reproduced at Appendix E.

Appendix F[7]. The reader may find it useful to refer to this template during the following description of the tool. Description of the tool begins with identification of four alternatives for collaboration.

1. Four Alternatives for Collaboration

The JDA normally procures defense items through one of the following five sources: "(1) domestic development, (2) co-development with the United States, (3), Licensed Production, (4) Commercial Imports, and (5) Foreign Military Sales (FMS)." [Ref. 41 p. 1]. This tool focuses on three procurement sources that will require collaboration at both the government-to-government and industry-to-industry level. These three sources are: Co-development, Licensed Production, and FMS. These three sources form the first three alternatives for collaboration. Each of these alternatives is defined below.

a. Co-development

Co-development is defined (by the researcher) as: that form of collaboration wherein defense contractors from the U.S., Japan, and (possibly) other countries jointly design, develop, and (usually) produce a weapon system. After-sales services of the jointly-developed systems may or may not be joint. This form of collaboration involves sharing of costs over the life of the program to include R&D and production overhead costs [Ref. 47 and Ref. 29 p. 4]. The FS-X program is an example of Co-development.

b. Licensed Production

Licensed Production "involves U.S. companies' use of munitions export licenses issued by the Department of State (after consultation with DoD and the Department of Commerce) to transfer the ability to produce U.S.-origin defense articles to either foreign governments or foreign companies.... the U.S.-origin defense articles proposed for licensed co-production may not even be in DoD use or may be a significantly modified version of DoD equipment in either development or production." [Ref. 47]. This tool assumes that derivative technologies developed as a part of the Licensed Production process will be shared and thus reduce the cost of improvements to

[7] This tool was developed from an example presented in Ref. 9 (p. 556).

the weapons system. An example of Licensed Production is the production of the Multiple-Launch Rocket system by Nissan Aerospace under license from the Lockheed-Martin Corporation.

c. FMS

FMS is known as "FMS co-production" by DoD [Ref. 47]. For the purpose of this tool, the "FMS" alternative is defined as: the sale of all or part of a weapon system for final assembly in Japan. FMS is distinguished from Licensed Production in that the majority of the weapons' production and assembly takes place in the U.S. This tool assumes that Japan may share some of the production overhead costs, but will not share any of the R&D costs for this type of collaboration. An example of this type of collaboration is the Aegis AAW radar. The radar is primarily assembled in the U.S. and a Japanese firm performs final installation on-board the designated vessel.

d. Do not Collaborate

The fourth alternative this tool considers is the alternative not to collaborate with Japan. This alternative assumes that the marginal benefits and marginal costs of the other three alternatives were evaluated and none of the three collaboration alternatives showed a positive marginal benefit.

2. Determination of Fundamental Objectives

The next step in building this tool is to determine the fundamental objectives. DoD considers alternatives to any acquisition program that have been identified to meet military requirements by evaluating the cost, schedule, and performance criteria of the program and of the identified alternatives. [Ref. 8]. This tool applies evaluation of cost, schedule, and performance in assignment three fundamental objectives. These three fundamental objectives are: (1) minimize cost, (2) minimize schedule risk, and (3) maximize performance.

a. Minimize Cost

When minimizing the cost of an acquisition program, the intent is not to just identify the cheapest alternative in terms of dollars programmed for expenditure. Rather, the Program Manager seeks to minimize cost in a manner that provides the best-value to the overall acquisition process. In evaluating the four possible collaboration

alternatives, this tool seeks to categorize the alternatives in relation to how they provide best value to the acquisition program in terms of overall cost minimization.

b. Minimize Schedule Risk

Proper time-phasing of acquisition efforts is critical to successful execution of an acquisition program. Collaboration involves some inherent risks to the development schedule in that more players (be they partners or customers) are part of the program. Aspects such as language or geography can create risks to the program schedule that are not present in a purely domestic effort. The interest of external audiences (e.g. Congress) can also create schedule risk in a collaboration effort. In evaluating the four possible collaboration alternatives, this tool seeks to assess the alternatives in terms of how they minimize schedule risk. This tool assumes that there is always some schedule risk present in any acquisition project and, rather than try to eliminate risk, it is further assumed that it is more effective to manage risk through identification and minimization of risk factors.

c. Maximize Performance

Maximization of performance means that the form of collaboration selected provides the highest possible return in performance of the system. Most acquisition programs establish key performance parameters that include both threshold (minimum) and objective (desired) levels of performance. Maximization of performance will normally entail meeting objective levels of performance. In evaluating the four collaboration alternatives, this tool seeks to assess the alternatives in terms of how they contribute to achievement of objective levels of performance.

3. Determination of Detailed Objectives

Detailed Objectives are those key elements that the decision maker considers for analysis of each fundamental objective on each alternative. Collectively these detailed objectives define important elements of each fundamental objective. Each collaborative acquisition effort might have its own set of detailed objectives. Determination of detailed objectives is a subjective process that involves multiple inputs to the decision maker. The decision maker must ask question such as: "What are the key elements in minimizing cost in this program?", "What elements of collaboration will increase

schedule risk?", and "How can I maximize performance of this system through collaboration?". The researcher identified a number of elements that were common to past acquisition interfaces with Japan. These detailed objectives are neither all-inclusive nor universally applicable to all collaborative acquisition projects. A fundamental objectives hierarchy is provided in Appendix G to illustrate the relationship between the fundamental and the detailed objectives.

a. Detailed Objectives for Minimizing Cost

(1) Share RDT&E Costs. This detailed objective enables evaluation of the benefits of sharing RDT&E costs with Japan. RDT&E costs are shared in co-development programs to a greater extent than in licensed production or FMS.

(2) Gain Economies of Scale. This detailed objective enables the evaluation of the impact of larger production quantities as a result of Japan and U.S. collaboration. Essentially the larger production quantities will result in lower per-unit production costs. Economies of Scale can be realized co-development, Licensed Production and FMS. Economies of Scale can also be realized if the U.S. does not collaborate, provided the DoD requirement is so extensive that addition of a foreign customer will not significantly affect the per-unit production cost.

(3) Take Advantage of the "Kokusanka Effect". This detailed objective enables the evaluation of the impact of a collaborative effort versus domestic production by Japan. Past acquisition interfaces indicate that Japan strongly favors cooperative development in particular areas (e.g. aerospace). This objective can have a positive or negative connotation. The positive aspect of this objective is that Japan may be dedicated to a collaborative effort in order to sustain the JDIB and gain access to advanced U.S. technologies (e.g. the TMD program). The negative aspect of this objective is that Japan may drive program costs higher in an effort to make the "collaborative" effort as indigenous as possible (e.g. the early phase of the FS-X program).

(4) Maximize Technology Transfer Costs and Benefits. This detailed objective enables the evaluation of the marginal benefit of technology transfer in the program under consideration. If the U.S. benefits from the transfer of technology from Japan then this objective would favorably consider some form of co-development over the other alternatives. If the a negative benefit is determined then Do not Collaborate might be the preferred alternative

(5) Integrate Commercial Items and Best Practices. This detailed objective enables the evaluation of the potential revenue benefits to U.S. and Japanese firms that might result from spin-off applications/dual-use applications. JDIB interest in dual-use applications in a particular acquisition project may create opportunities for collaboration in co-development, Licensed Production, or FMS.

b. Detailed Objectives for Minimizing Schedule Risk

(1) Minimize Schedule Risks in Bilateral RDT&E. This detailed objective enables evaluation of the impact of a collaborative RDT&E effort on the overall program schedule. Past acquisition interfaces indicate that co-development programs create the greatest risk to the program schedule due primarily to the problems inherent in language, geography and the involvement of a larger sphere of development personnel.

(2) Take Advantage of JDIB Proficiency. This detailed objective enables evaluation of the impact of the JDIB's inherent characteristics on the development schedule. The JDIB can have advanced proficiency in production of some component items (e.g. radar production for the FS-X) and this proficiency may lend itself to favorable evaluation of a co-production or licensed production alternative. However, the JDIB's relatively small size and customer base may result in few proficiency advantages for DoD.

(3) Create Positive Congressional Interest. This detailed objective enables evaluation of the impact of Congressional Interest on the progress of the program and the surety of funding. If Congress views the collaborative effort as positive, this condition could tend to lessen schedule risk as Congress may be willing to allocate more resources to keep a program on schedule. Conversely, adverse Congressional interest in the collaborative effort may create significant increases in

schedule risk as Congress seeks to exercise its oversight authority in collaborative programs.

(4) Integrate Commercial Items and Best Practices. This detailed objective enables the evaluation of the impact of synergies in application of commercial technologies in both countries to the acquisition project. If the project under consideration can use already-developed commercial technologies, this will tend to mitigate schedule risk by reducing the developmental time required.

c. Detailed Objectives for Maximizing Performance

(1) Use Shared RDT&E to Maximize Performance

This detailed objective enables evaluation of the potential benefits to system performance through cooperative RDT&E. For example, Japan may possess the technology to significantly reduce the weight of an aircraft through application of advance composite material techniques. If this were the case, then co-development of either: the entire aircraft, flight control surfaces, or fuselage, might be a favored alternative.

(2) Enhance Interoperability

This detailed objective enables evaluation of the impact of greater interoperability of equipment as a result of some form of collaboration. Common equipment may encourage shared training and doctrine and thus enable more effective usage of the item.

(3) Integrate Commercial Items and Best Practices

This detailed objective enables the evaluation of the presence of existing commercial applications in either Japan or the U.S. that can enhance the performance of the system under consideration. For example, both the U.S. and Japan are seeking ways to incorporate the rapid advancements in commercial communication devices (both voice and data) into military applications.

Thus far, the researcher has defined the fundamental and the detailed objectives. To effectively utilize this tool, it is necessary to describe the Program Manager's relative preferences among the objectives. To describe these preferences, a weighting technique is employed to assign relative weights to each category of objectives.

4. Weighting the Objectives

Weighting the fundamental objectives involves conducting a relative assessment of the fundamental objectives that reflects the Program Manager's preferences for each objective. The “Swing Weighting” technique is employed in this tool. Other procedures for weighting objectives include Pricing Out and Lottery Weighting. Pricing Out and Lottery Weighting may also be used effectively to assign weights in this tool. Instructions on how to employ Pricing Out and Lottery Weighting are described in Reference 9.

a. Swing Weighting the Fundamental Objectives

Swing Weighting of the Fundamental Objectives requires the Program Manager to compare worst-case outcomes. The first step in Swing Weighting is to create a matrix such as the one in Table 8 (see next page). The first row is a "Benchmark" for the worst-case outcome. In this tool, the worst-case outcome is highest cost, lowest performance, and most schedule risk. In the second step, possible outcomes are described by "swinging" one of the objectives from worst to best. Once the table is constructed, the third step is to assess each of the outcomes.

The first step in assessment of the outcomes is to rank-order the outcomes. The benchmark is given the lowest rank as it reflects the worst possible outcome. The other objectives are assessed to determine which ranks first, second, and third.

The second step in assessment is to rate the outcomes based on the rankings. Any scale may be used for this rating; however, the ratings should reflect a value commensurate with the rankings. In Table 8, the researcher has ranked and rated performance maximization as the most important objective. The researcher rated cost minimization as 75. This implies that improving cost from worst to best is worth 75 percent of the value that is gained by acquiring system that performs at or above objective requirements.

The third step is to calculate the weight for each objective. The weight is the ratio of the individual Rate to the sum of the Rates and is expressed as a percentage value. These weights are transferred to the tool for inclusion in utility calculations. This

process completes the weighting of the Fundamental Objectives. The next step in constructing the tool is to weight the detailed objectives.

Fundamental Objective	Outcome	Rank	Rate	Weight
(Benchmark)	Highest Cost, Worst Performance, Most Schedule Risk	4	0	N/A
Minimize Cost	Lowest Cost, Worst Performance, Most Schedule Risk	2	75	33.2%
Minimize Schedule Risk	Least Schedule Risk, Highest Cost, Worst Performance	3	51	22.6%
Maximize Performance	Best Performance, Most Schedule Risk, Highest Cost	1	100	44.2%
		Total	226	100%

Table 8. Swing Weighting Matrix for Fundamental Objectives

b. Swing Weighting the Detailed Objectives

The researcher chose the Swing Weighting technique to weight the Detailed Objectives. Other weighting techniques are equally applicable as noted in the previous section. The methodology for Swing Weighting the Detailed Objectives is identical to the methodology employed for weighting the Fundamental Objectives. Table 9 (see next page) provides a sample matrix of weights for the Detailed Objectives associated with the Fundamental Objective-Maximize Performance.

These weights are transferred to the tool for inclusion in the utility calculation. Weighting of the Fundamental and Detailed Objectives completes the weighting process. The next step in building the assessment tool is to assess the utility of each alternative in relation to each Detailed Objective.

5. Utility Scoring Methodology

In addition to the weighting of objectives, the Additive Utility function requires the assessment of individual utility values for each alternative on each Detailed Objective. Several techniques are available to assess utilities[8]. The researcher selected a ratio comparison technique because it is "a particularly appropriate (technique) for attributes that are not naturally quantitative" [Ref. 9 p. 544].

Detailed Obj.	Outcome	Rank	Rate	Weight
(Benchmark)	Did not Use Shared RDT&E, Did not Integrate Comm. Items, Did not Enhance Interoperability.	4	0	N/A
Use Shared RDT&E	Used Shared RDT&E, Did not Integrate Comm. Items, Did not Enhance Interoperability.	1	100	50%
Enhance Interoperability	Enhanced Interoperability, Did not Use Shared RDT&E, Did not Integrate Comm. Items.	3	20	10%
Integrate Comm. Items	Integrated Comm. Items, Did not Enhance Interoperability, Did not Use Shared RDT&E.	2	80	40%
		Total	200	100%

Table 9. Swing Weighting Matrix for Detailed Objectives Associated with Maximizing Performance

In the ratio comparison technique, preferences are described by assigning relative values to each alternative within a detailed objective. For example, within the Fundamental Objective-Minimize Cost, we want to describe the relative utility of each collaboration alternative as it relates to the Detailed Objective-Share RDT&E Costs. The

[8] See Ref. 9 for a sample of alternate techniques.

decision-maker could use a scale from 0 to 100 and make the following assessment: Co-development = 75, Licensed Production = 10, and FMS and Do not Collaborate = 0. This assessment indicates that the decision-maker thinks that co-development has the greatest utility in terms of sharing RDT&E costs, there is some potential for sharing RDT&E costs in Licensed Production, and there is no potential for cost sharing in FMS or Do not Collaborate. Once this assessment is made the scores must be scaled so that they range from 0 to 1. An explanation of the scaling technique is provided at Appendix H. The resultant scaled scores are: Co-development = 1.0, Licensed Production = 0.13, and FMS and Do not Collaborate = 0. These scores are transferred to the tool. The next step in determining the utility of each alternative is to calculate the overall utility of each alternative.

6. Calculation of Overall Utility

The overall utility of each alternative is calculated using an additive utility function. This function requires the multiplication of the individually scaled utilities by the applicable weights. These products are then summed to determine and overall utility.

a. Abbreviation Methodology

To formally express this function the researcher developed abbreviations for the Fundamental and Detailed Objectives. Abbreviations used for the Fundamental Objectives are: Minimize Cost(C), Minimize Schedule Risk(S), and Maximize Performance(P). Each Detailed Objective was identified by sequentially numbering it within its Fundamental Objective. For example, "Share RDT&E Costs" is the first Detailed Objective in the Fundamental Objective "Minimize Cost"; therefore, this Detailed Objective is identified as "C1". The second Detailed Objective in Minimize Cost is "Gain Economies of Scale"; therefore this Detailed Objective is identified as "C2". The remainder of the Detailed Objectives are abbreviated in this manner.

The weights for the Objectives are identified using the letter "k" to denote a weight in combination with the abbreviation methodology described above. For example, the weight associated with the Detailed Objective "Share RDT&E Costs" is abbreviated as "k_{C1}".

The individual scaled utilities on each alternative associated with each Detailed Objective are identified using the letter "U", with an abbreviation identifying the alternative and the abbreviation methodology described above. The alternatives are abbreviated as follows: Co-development="dev", Licensed Production="pro", FMS="fms" and Do not Collaborate="dc". For example, the abbreviation for the scaled utility value associated with the Fundamental Objective-Minimize Cost, the Detailed Objective, Share RDT&E Costs, and the alternative Co-development is abbreviated as: "U_{c1dev}".

b. Overall Utility Equations

Using this abbreviation methodology, the calculation for the overall utility for each alternative can be described by the following four equations:

Equation #1: Utility of Co-Development =

$$\mathbf{(k_C(k_{C1}U_{C1dev} + k_{C2}U_{C2dev} + k_{C3}U_{C3dev} + k_{C4}U_{C4dev} + k_{C5}U_{C5dev}) + k_S(k_{S1}U_{S1dev} + k_{S2}U_{S2dev} + k_{S3}U_{S3dev} + k_{S4}U_{S4dev} + k_{S5}U_{S5dev}) + k_P(k_{P1}U_{P1dev} + k_{P2}U_{P2dev} + k_{P3}U_{P3dev} + k_{P4}U_{P4dev} + k_{P5}U_{P5dev}))*100}$$ [9]

Equation #2: Utility of Licensed Production =

$$\mathbf{(k_C(k_{C1}U_{C1pro} + k_{C2}U_{C2pro} + k_{C3}U_{C3pro} + k_{C4}U_{C4pro} + k_{C5}U_{C5pro}) + k_S(k_{S1}U_{S1pro} + k_{S2}U_{S2pro} + k_{S3}U_{S3pro} + k_{S4}U_{S4pro} + k_{S5}U_{S5pro}) + k_P(k_{P1}U_{P1pro} + k_{P2}U_{P2pro} + k_{P3}U_{P3pro} + k_{P4}U_{P4pro} + k_{P5}U_{P5pro}))*100}$$

Equation #3: Utility of Foreign Military Sales =

$$\mathbf{(k_C(k_{C1}U_{C1fms} + k_{C2}U_{C2fms} + k_{C3}U_{C3fms} + k_{C4}U_{C4fms} + k_{C5}U_{C5fms}) + k_S(k_{S1}U_{S1fms} + k_{S2}U_{S2fms} + k_{S3}U_{S3fms} + k_{S4}U_{S4fms} + k_{S5}U_{S5fms}) + k_P(k_{P1}U_{P1fms} + k_{P2}U_{P2fms} + k_{P3}U_{P3fms} + k_{P4}U_{P4fms} + k_{P5}U_{P5fms}))*100}$$

[9] "The factor of 100 at the end simply changes the scale so that it ranges from 0 to 100" [Ref. 9 p. 555].

Equation #4: Utility of Do not Collaborate =

$$(k_C(k_{C1}U_{C1dc} + k_{C2}U_{C2dc} + k_{C3}U_{C3dc} + k_{C4}U_{C4dc} + k_{C5}U_{C5dc}) +$$

$$k_S(k_{S1}U_{S1dc} + k_{S2}U_{S2dc} + k_{S3}U_{S3dc} + k_{S4}U_{S4dc} + k_{S5}U_{S5dc}) +$$

$$k_P(k_{P1}U_{P1dc} + k_{P2}U_{P2dc} + k_{P3}U_{P3dc} + k_{P4}U_{P4dc} + k_{P5}U_{P5dc}))*100$$

Upon completion of calculations, Equations 1-4 are compared and the alternative with the highest overall utility is the preferred alternative.

In review, comparing the four collaboration alternatives is a seven-step process:

Step 1 - Develop Fundamental and Detailed Objectives for the Acquisition Program.

Step 2 - Organize the Fundamental and Detailed Objectives in a Fundamental Objectives Hierarchy.

Step 3 - Weight the Fundamental Objectives.

Step 4 - Weight the Detailed Objectives.

Step 5 - Evaluate the alternatives on each Detailed Objective.[10]

Step 6 - Calculate the overall utility of each alternative using Equations 1-4.

Step 7 - Choose the alternative with the highest overall utility.

This seven-step process results in the assignment of an objective utility value for each collaboration alternative. This utility value incorporates cost only as cardinal parameter (i.e. higher or lower). Collaboration costs may sometimes be estimated and these utility values are useful in evaluation of actual program cost as an attribute.

7. Introducing Actual Program Cost as an Attribute

In using this tool, the researcher included evaluation of cost only in a broad sense. The tool does not require the use of actual cost estimates to determine an overall utility for each alternative. However, in the course of evaluating collaboration alternatives, Program Managers may develop a cost estimate for each collaboration alternative. If a

[10] Clemen recommends evaluating the attributes prior to determining the weights for the objectives. The researcher found that evaluating the alternatives first, provided an incentive to bias the weights.

cost can be assigned to each alternative, then a further assessment can be made. The first step is to construct a Cost/Utility Assessment matrix such as the one presented in Table 10.

The second step is to graph the cost and utility of each alternative with Cost on the X-axis and Overall Utility on the Y-axis. A sample graph is provided at Figure (1) .

ALTERNATIVE	COST (Millions-FY00$)	OVERALL UTILITY
Co-development	130	57.06
Licensed Production	150	29.24
FMS	108	22.20
Do not Collaborate	160	1.61

Table 10. Cost/Utility Assessment Matrix

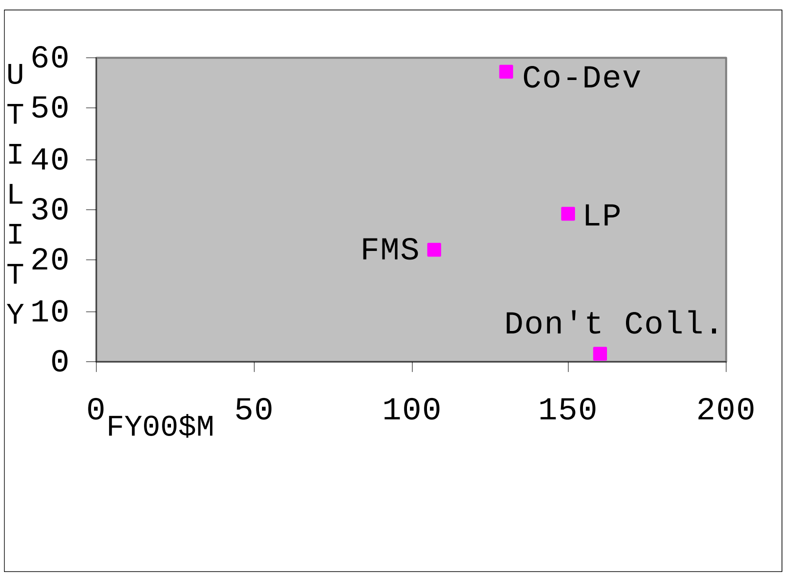

Figure 1. Cost versus Utility Graph

The third step is to identify the presence of any dominating or dominated alternatives. In the example presented at Figure (1), the alternative "Do not Collaborate" is clearly dominated by the other three alternatives because it has the greatest cost but the lowest overall utility. The example indicates that, Licensed Production is dominated by

Co-development because Co-development provides greater utility for less cost than Licensed Production. Therefore, in this example, the Program Manager might narrow consideration of alternatives to include only Co-development and FMS.

This three-step process identifies how introducing cost as an attribute can potentially help to narrow the field of alternatives. When cost and utility are evaluated as presented in this tool, the Program Manager has an objective evaluation of collaboration alternatives. However, the tool is not designed to function as a stand-alone element of the program management process and some critical assumptions must be made.

8. Critical Assumptions of the Tool

This tool can provide a program manager with a relative assessment of collaboration alternatives with Japan. This tool employs several critical assumptions:

(1) The individual(s) who prepares the tool understand(s) the theory behind additive utility.

(2) In gathering data, the Program Office is consistent in its methodology for soliciting information about subjective preferences. This assumption is particularly critical in the ratio-weighting portion of the utility calculation-inconsistent collection of preference data may result in skewed utility values.

(3) This tool will be employed early enough in the acquisition process to allow for sufficient evaluation of all alternatives. This assumption implies that the decision maker will use this tool early in the requirements development process[11] to ensure that each alternative (e.g. co-development) is available for consideration and not eliminated due to program maturity.

9. What the Tool Does and Does Not Tell the Program Manager

This tool can help the Program Manager to objectively evaluate collaboration alternatives by assigning an overall utility value to each alternative. This tool is useful in that it provides a relative comparison of alternatives and represents the subjective preferences of the decision maker. This tool cannot tell the Program Manager if the preferences are the right preferences for this acquisition project. The tool also cannot

[11] See Appendix I for a Model of the current DoD acquisition process

incorporate every objective of every stakeholder for a given acquisition project. This tool simply provides a Program Manager with a snapshot in time of preferences for (or against) collaboration with Japan. This snapshot may be useful in determining where to apply program resources in future phases of the acquisition process. In the next section, the researcher applies the tool to the FS-X program as demonstration of its usefulness in evaluating collaboration alternatives.

C. APPLYING THE TOOL TO THE FS-X (F-2)

This section provides a sample application of the assessment tool. The researcher selected the FS-X program for application because the researcher the researcher was able to obtain adequate data from References 28 and 30 to make a sample assessment. This application is presented using the seven-step method for determining the overall utility of each collaboration alternative:

Step 1 - Develop Fundamental and Detailed Objectives for the Acquisition Program.

Step 2 - Organize the Fundamental and Detailed Objectives in a Fundamental Objectives Hierarchy.

Step 3 - Weight the Fundamental Objectives.

Step 4 - Weight the Detailed Objectives.

Step 5 - Evaluate the alternatives on each Detailed Objective.

Step 6 - Calculate the overall utility of each alternative using Equations 1-4.

Step 7 - Choose the alternative with the highest overall utility. The completed assessment matrix is provided at Appendix J. Prior to applying the tool, the researcher made four critical assumptions.

1. Critical Assumptions

The researcher made four critical assumptions to facilitate application of the assessment tool to the FS-X:

(a) The researcher prepared this tool as if he were a staff member in the F-16 program office in 1985.

(b) This staff member was required to analyze four collaboration alternatives with Japan and make a recommendation on which alternative would best fulfill DoD's primary objective (i.e. stopping indigenous development of a Japanese fighter).

(c) The staff member accepted the Fundamental Objectives, the Detailed Objectives, and the Objectives hierarchy as presented in the previous section.

(d) The staff member conducted some preliminary research and was able to determine that Japan did have some advanced technologies that might create added value to the F-16 program.

Before moving to Step 3 (weighting the Fundamental Objectives) the staff member decided to clearly define what each collaboration alternative actually meant in the FS-X program.

2. Defining the Alternatives

The four collaboration alternatives selected for analysis were: Co-development, Licensed Production, FMS, and Do not Collaborate. Each of these alternatives is more precisely defined below:

(a) Co-development: This alternative involves U.S. - Japan development of an aircraft loosely based on the F-16 airframe. The aircraft would mostly contain systems that were either developed or licensed-produced in Japan. While the aircraft would outwardly resemble an F-16, its power plant, avionics, and flight control systems, would be the result of an extensive R&D effort by both the U.S. and Japan and would result in a radically updated version of the F-16.

(b) Licensed Production: This alternative involves U.S. sharing of F-16 technologies to allow for production of a "minimally modified" F-16 by a Japanese manufacturer. The manufacturer would most likely be a consortium headed by MHI. "Minimally modified" implies that Japan might include changes to the F-16 like incorporation of its Active Phased Array (APA) antennas. Selection of this alternative would imply that most component items would be fully assembled in Japan with more than 51% of the components produced by a Japanese manufacturer (this includes

components that were indigenously developed and those manufactured under license (e.g. the engine)).

(c) FMS: This alternative involves selling a partially assembled F-16 to Japan. Like the Licensed Production alternative, this alternative might include minimal modifications to the aircraft (e.g. incorporation of the APA). This alternative implies that most of the component items would be manufactured and fully assembled in the U.S. and a Japanese manufacturer would produce less than 51% of the components. Final assembly of the aircraft would take place in Japan (probably done by MHI). In essence, this alternative involves selling Japan an F-16C that incorporated some Japanese technologies but; most F-16 technologies would be "black-boxed" and the Japanese would not have access to detailed information (i.e. the Japanese would probably be unable to "reverse engineer" the technology for future civilian or military aerospace applications).

(d) Do not Collaborate: This alternative implies that Japan will indigenously develop its own fighter aircraft. In this alternative, the analysis considers the marginal benefit of preventing aircraft development (DoD's goal) against the marginal cost of giving Japan access to F-16 technology (a Congressional concern).

The next step in building the tool was to weight the Fundamental Objectives.

3. Weighting Fundamental Objectives

The primary consideration in weighting the fundamental objectives is to incorporate DoD's goal of thwarting indigenous development of a Japanese fighter aircraft. To this end, maximization of performance was given the greatest weight at 50 percent. This weighting emphasizes that DoD can provide a proven airframe and that is scalable and expandable to Japanese defense needs. Interoperability with U.S. systems would also allow Japan to reap performance benefits from upgrades to later F-16 versions.

Cost was weighted at 30 percent and this reflects the reality of Japanese defense spending. Japanese defense spending is constrained by the unofficial "1 percent of GDP cap" and this means that is a recurrent issue for Japan in procurement of major weapons systems. Although Japan wants a significantly improved aircraft (over its F-1), it has to

consider the procurement costs within the confines of a relatively small procurement budget.

Schedule Risk was weighted at 20 percent. Japan is willing to undertake a ten-year development process in order to get the type of aircraft they want. Therefore, it is assumed that increased schedule risk is an acceptable factor given that the proposed aircraft provides the desired level of performance at a reasonable cost. However, Japan has a fleet of aging fighter aircraft and Japan risks having fighter aircraft that are not comparable to its regional rivals in the near-term; therefore, Schedule Risk was not discounted entirely.

The next step in tool development was to weight the Detailed Objectives

4. Weighting the Detailed Objectives

a. Detailed Objective Weights for Minimizing Cost

Taking advantage of the Kokusanka Effect was assessed as the key element in gaining best-value for this collaborative project and was given a weight of 41.7 percent. There is a strong desire in Japan to obtain advanced aerospace technologies. Both Japanese government and industry heavily favor purely indigenous production of the aircraft. Indigenous production by Japan will tend to push up unit costs because Japanese industry does not enjoy the scale or experience of U.S. industries and a collaboration alternative that takes advantage of the Kokusanka Effect might prove beneficial to both sides.

Maximizing Technology Transfer Costs and Benefits was weighted at 33.3 percent in recognition of the U.S. desire to gain some benefit from transferring advanced F-16 technologies to Japan. This weight also reflects the potential gain from the flowback of derived technologies from the Japanese side.

The Detailed Objectives: Share RDT&E Costs, Gain Economies of Scale, and Integrate Commercial Items and Best Practices; were given equal weights of 8.3 percent. While each of these objectives is important, they are intrinsic to the existing F-16 program and it is assumed these objectives were previously optimized.

b. Detailed Objective Weights for Minimizing Schedule Risk

Creating positive Congressional Interest was given the greatest weight of 55.6 percent. This weighting reflects Congressional concerns over parity in technology transfer on this project. Congress could impede the progress of the program through regulatory measures and hearings on various aspects of development. Creating positive Congressional Interest would be essential to assure a reasonable development and production schedule.

Taking advantage of JDIB Proficiency was given the next greatest weight at 33.3 percent. This weight recognizes the need to select a collaboration alternative that allows the program to build upon advanced Japanese technologies (e.g. the APA radar). Through incorporation of the best of Japanese technologies, program schedule risk could be mitigated.

The Detailed Objectives for minimizing bilateral RDT&E risks and integration of commercial items and best practices; were given equal weights of 5.6%. The bilateral RDT&E weight recognizes the U.S.' desire for Japan to use a minimally modified F-16 that does not require extensive RDT&E. Integration of commercial items and best practices to mitigate risk is assessed as already present in both countries' development efforts, although new commercial items and practices may be available for integration later.

c. Detailed Objective Weights for Maximizing Performance

The Detailed Objective "Enhance Interoperability" was given the greatest weight at 62.5 percent. By bringing Japan into the F-16 program, the U.S. could benefit through shared training and doctrine. Greater interoperability between the Air Forces of the two countries could strengthen political ties and serve as catalyst for more combined maneuvers/exercises. Japan could provide feedback on aircraft performance characteristics and contribute to continued improvement of the aircraft.

Using shared RDT&E was rated at 31.3 percent because this was the key objective in the minimal RDT&E effort that the U.S. wanted. This weight reflects the desire to use existing RDT&E efforts in both countries to create an aircraft which functions at or above objective levels of performance.

Integration of commercial items and best practices was rated at 6.3 percent because commercial items and practices were assessed as having only minimal impact on the performance characteristics of the existing aircraft. In this program, commercial items and practices will probably have a greater impact in reducing procurement costs and schedule risks than in enhancing performance.

5. Scoring Individual Utilities on the Detailed Objectives[12]

a. Detailed Objectives for Minimizing Cost

(1) Share RDT&E Costs. The U.S. would prefer not to engage in a major R&D effort. However, if it were necessary to undertake major R&D for this program the U.S. would most likely prefer some form of co-development in order to equitably spread the R&D costs between both countries. This preference would be followed by a limited R&D effort to improve existing processes in a Licensed Production alternative. The remaining alternatives hold no utility for sharing R&D costs.

(2) Gain Economies of Scale. The U.S. would gain the greatest utility in this objective through the FMS alternative. This utility reflects the fact that most components would be manufactured and assembled in the U.S. Licensed Production has the next greatest utility because the U.S. would still produce some components. Do not collaborate has some utility in this objective because the U.S. might lose some cost savings if it entered co-development with a Japanese manufacturer who had higher overhead costs and/or less experience. Therefore, Do not Collaborate has more utility than co-development.

(3) Take Advantage of the "Kokusanka Effect". Japanese industry and government heavily favor indigenous development of this aircraft because it is viewed in the JDIB as the cornerstone of future Japanese defense aerospace R&D. Therefore, co-development was given the highest utility. Licensed Production and FMS are seen as more favorable to the U.S., but less likely to ameliorate Japanese concerns over indigenous development. If the U.S. elects not to collaborate, then there is no attempt to meet this objective.

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[12] This section gives the researcher's rationale for scoring. Actual scores can be found in Appendix J

(4) Maximize Technology Transfer Costs and Benefits. FMS is the preferred U.S. alternative for this objective. Although Japan possesses some advanced radar technologies, and may provide flowback of derived technologies; the U.S. will probably benefit from "black-boxing" as many of the F-16 technologies as possible. In terms of this objective, Do not Collaborate is probably favored over Licensed Production because Licensed Production would likely involve a great deal of technology transfer with no guarantee of flowback of equally sophisticated Japanese technologies. Co-development is assessed as having no utility in achievement of this objective.

(5) Integrate Commercial Items and Best Practices. There appears to be very little direct application of commercial technologies in this project. Some process improvements might be realized in Licensed Production or FMS, however, the utility of these improvements would most likely be very limited.

b. Detailed Objectives for Minimizing Schedule Risk

(1) Minimize Schedule Risks in Bilateral RDT&E. For the U.S. side, FMS provides the least schedule risk because RDT&E requirements will flow from the need to integrate any Japanese components. However, Japan seems more likely to agree to a slightly more expansive RDT&E effort. Therefore, Licensed Production seems to have slightly greater utility in achievement of this objective than FMS. If the U.S. chooses not to collaborate, then there is no schedule risk but this might be an equal trade-off when compared to the relatively minimal schedule risks implied in FMS and Licensed Production. Full co-development presents significant schedule risk, but is an alternative that Japan probably favors; even if this means extended development and procurement schedules.

(2) Take Advantage of JDIB Proficiency. FMS and Licensed Production seem to provide equal utility for the U.S. Both of these alternatives provide for Japanese production of some components. Japan seems more likely to favor co-development, but the U.S. could probably make a compelling case that Licensed Production would more effectively balance the Japan's desire for indigenous development with the recognition that the small size and scale of the JDIB substantially increases unit costs. Therefore, Licensed Production was given the greatest utility, followed by FMS, and co-development.

(3) Create Positive Congressional Interest. Congress is currently not in favor of this program and sees it as a "give-away" of U.S. technology. The alternative with the highest overall utility for DoD is to simply abandon a collaborative effort altogether. However, if some sort of FMS alternative was negotiated that created more aircraft production in key Congressional districts, then this alternative might enable achievement of the DoD objective and create positive (vice the current negative) Congressional Interest.

(4) Integrate Commercial Items and Best Practices. Commercial items and best practices are seen as having limited utility within this objective. Future integration of best commercial manufacturing practices might help to speed the component production process in Licensed Production or FMS.

c. Detailed Objectives for Maximizing Performance

(1) Use Shared RDT&E to Maximize Performance. Japan heavily favors an extensive RDT&E effort to create a high-performance fighter that is "essentially" Japanese. A co-development program would provide the greatest opportunity to find performance improvements in the F-16 program. The limited nature of RDT&E in Licensed Production and FMS would probably provide only marginal increases to performance.

(2) Enhance Interoperability. FMS has the greatest utility for DoD in achievement of this objective. The FMS alternative would provide a minimally-modified F-16C to Japan and provide the opportunity for synergies in training and doctrine. Some utility might be present in Licensed Production alternative as well, but there would likely be a great deal of variation in models. Co-development would probably result in an aircraft that was substantially different from the F-16 and any interoperability synergies would be minimal.

(3) Integrate Commercial Items and Best Practices. Integration of commercial items and best practices to maximize performance has limited application in this aircraft. Some performance enhancements might "spin-on" from the commercial sector in an extensive co-development program. The JDIB may have some contributions to aircraft manufacturing process (e.g. using composites materials) in a Licensed Production or FMS alternative, but the value of these potential contributions is assessed as very limited.

6. Calculation of Overall Utility

Additive Utility Theory was used to calculate the overall utility of each alternative based on the criteria outlined above. The following utility values were determined:

Co-development: 23.50

Licensed Production: 55.87

FMS: 72.38

Do not Collaborate: 18.95

7. Assessment of the Preferred Alternative

FMS is the favored form of collaboration followed by Licensed Production. Some form of collaboration is probably favorable given the relatively low score for Do not Collaborate. Although Japan favors indigenous development or co-development, Licensed Production may prove to be a form of collaboration that Japan is willing to consider if DoD can resolve technology transfer issues to the satisfaction of both Japan and Congress. An FMS package that incorporated significant cost savings to Japan (i.e. passing and economy of scale savings along to Japan in the form of lower per unit aircraft price) might mitigate Japanese concerns over losing industrial base developmental capability. Although FMS is DoD's favored alternative, a Licensed Production alternative seems more likely to facilitate DoD's goal for this program.

D. OTHER TOOLS FOR ASSESSSMENT OF ACQUISITION OPPORTUNITIES

1. Software Alternatives

Clemen recommends using a software package entitled "Logical Decisions" in decision situations involving multiple objectives. "The starting point in this program is to create a fundamental objectives hierarchy." [Ref. 9 p. 83]. This software package closely parallels the researcher's tool and it "permit(s) the user to specify attribute scales, identify alternatives, and to indicate how each alternative is evaluated on each attribute" [Ibid p. 83]. This software may be useful to a Program Manager who does not favor the use of ratio weighting or some other "manual" form of scoring the utilities on each collaboration alternative. This software is available on the World Wide Web at: http://www.logicaldecisions.com.

Another applicable software alternative is entitled "Expert Choice". This software is similar to Logical Decisions. Expert Choice uses the Analytic Hierarchy Process (AHP). "AHP assists with the decision making process by allowing decision makers to organize and evaluate the significance of criteria (objectives) and alternative solutions of a decision" [Ref. 45 p. 11]. This software is more sophisticated than the researcher's tool in that it allows the decision maker to "do what-if or graphical sensitivity analysis to quickly determine how a change in the importance of an objective may influence the alternatives of choice." [Ibid p. 11]. This software is recommended if the program under consideration requires (and has data to support) graphical sensitivity analysis. This software is in wide use in the U.S. Government (including the military departments). Information on how to obtain Expert Choice software is available on the World Wide Web at http://www.expertchoice.com.

2. Value-focused Thinking

Value-focused Thinking is "a philosophical approach for guiding and integrating your decision-making activities." [Ref. 27 p. 1]. Value-focused Thinking is a method to link program objectives and overall defense procurement strategy with determination of alternatives for international collaboration. Value-focused Thinking might enable a program manager to develop other collaboration alternatives than the ones presented here

(or combinations of the alternatives presented here). These collaboration alternatives might be more directly linked to long-term DoD acquisition strategies.

Value-focused Thinking provides the Program Manager with a different decision support tool than the alternative-focused tool developed by the researcher. "Value-focused thinking is a way to identify desirable decision situations and then reap the benefits of these situations by solving them" [Ibid p. 2]. The researcher found that the Value-focused thinking approach was useful in evaluation of the collaboration alternatives on each detailed objective (i.e. Step 5 of the tool development process). Procedures for implementing Value-focused thinking in decision-making can be found in Value-Focused Thinking: A Path to Creative Decision-making by Ralph L. Kenney. For an example of military application of Value-focused thinking see: "An Operational Analysis for Air Force 2025: An Application of Value-Focused Thinking to Future Air and Space Capabilities" available on the World Wide Web at http://papers.maxwell.af.mil.

Software alternatives and Value-focused Thinking are alternative methods for evaluation of acquisition opportunities with Japan. Evaluation of collaboration alternatives involves the assessment of the relative costs and benefits of each acquisition opportunity. Acquisition opportunities exist in the form of specific weapons' programs. There are also opportunities to develop acquisition policies with Japan that enable optimization of collaborative efforts.

E. OPPORTUNITIES FOR ACQUSITION POLICY DEVELOPMENT

This chapter has outlined several acquisition opportunities for DoD within the JDIB, and has described a tool (and alternatives) for evaluating these opportunities. DoD should also evaluate the impact of current acquisition polices on development of bilateral acquisition opportunities. The researcher identified four potential hurdles to maximization of acquisition opportunities with Japan: (1) constraints imposed by the Three Principles on Arms Export, (2) inadequate involvement by JDA in the requirements development process, (3) absence of a General Security of Military Information Agreement (GSOMIA), and (4) complex rules and regulations governing acquisition projects with Japan.

1. Three Principles on Arms Export

The Three Principles on Arms Export inhibit Japan's ability to conduct international collaboration in weapons' procurement. The principles themselves are somewhat antiquated in referring to a "communist bloc" and may need to be revised to more clearly reflect Japan's resistance to arms export to "non-aligned" nations. In any form, the Three Principles have a fundamental impact on the evaluation of collaboration alternatives. This fundamental impact is that the Three Principles eliminate a collaboration alternative from consideration. The eliminated alternative is reciprocal trade.

Lorell defines reciprocal trade as an agreement between governments wherein "each government agrees to purchase weapons or weapons systems developed and produced by defense contractors in the partner country." [Ref. 29 p. 4]. This type of collaboration is strongly favored by the U.S.' transatlantic acquisition partners (e.g. Germany and the United Kingdom). Japan's restriction on arms exports disincentivizes the JDIB from participation in this type of program. While Japan can import weapons from the U.S. and co-develop (or co-produce) weapons with the U.S.; Japan cannot export weapons to the U.S. This restriction significantly decreases the economic incentive to engage in any sort of reciprocal trade agreement.

The Three Principles are an impediment to a full and open weapons' acquisition market with Japan. The U.S. would benefit from amendment of the Three Principles in that amendment might allow for a collaborative weapons' acquisition environment that more closely approximates that of the U.S.'s transatlantic partners. Unless and until the Three Principles are revised, Japan will be viewed by the U.S. as a second-tier player when compared to the U.S.' transatlantic acquisition partners. The constraints imposed by the Three Principles also create a hurdle to development of long-term acquisition plans and this hurdle is discussed in the next section.

2. Inadequate JDA Involvement in Requirements Development

Japan and the U.S. have "more common equipment than any other U.S. friend/ally" [Ref. 43 p. 5]. Despite this commonality, the U.S. maintains its de facto role as a provider of security assistance rather than as a true acquisition partner with Japan.

The U.S. stance is reflected in "(e)xcessive use of bureaucratic FMS procedures; (and) arbitrary restrictions on release of U.S. systems/technologies." [Ibid p. 6]. This type of relationship fosters a climate in which there is little long-term acquisition policy coordination between JDA and DoD. Specifically, there is no on-going "requirements dialogue on common interests in future defense systems." [Ibid p. 8]. The absence of a requirements dialogue has generated an ad-hoc, program-to-program policy structure with no institutional history. The U.S. and Japan effectively "reinvent the wheel" for each new cooperative program.

Acquisition opportunities for the U.S. and Japan could be more readily evaluated if a strategic dialogue was present that "considers not only existing defense plans (e.g. Quadrennial Defense Review and the MTDP)"., but also considers "(the) impact of the Revolution in Military Affairs, future roles and missions for U.S. and Japanese forces, and appropriate force structures in the Asia/Pacific region" [Ibid p. 9].

DoD would benefit from this type of strategic dialogue in that it might provide a "more flexible approach to (Japanese) arms export policies" [Ibid p. 11]. DoD may find that an on-going requirements dialogue creates process improvements through conclusion of less restrictive MOUs and creates greater interface between program offices and defense firms in both countries [Ibid p. 11]. Continued absence of this type of dialogue may hobble future acquisition efforts as defense systems become more complex (and costly) and the ad-hoc U.S. - Japan arrangement is viewed as too unwieldy to cope with complicated defense acquisition projects. The increasingly complex nature of defense acquisition projects and problems with the Japan-U.S. acquisition interface are also reflected in discussion of the next hurdle, absence of a General Security of Military Information Agreement.

3. Absence of a GSOMIA

The absence of a General Security of Military Information Agreement with Japan hobbles the acquisition development process. The absence of a GSOMIA has been an issue between the U.S. and Japan since the 1980s. The U.S. and Japan have collaborated on projects that required the sharing of sensitive information (e.g. the TDP for the F-16 during the FS-X program) and both U.S. and Japanese officials agree: "GSOMIA

requirements were being met in practice on U.S. - Japanese programs (however,) GOJ officials (have) cited political controversy over any apparent tightening of Japanese regulatory controls." [Ref. 33 p. 1]. In the absence of a GSOMIA, "the U.S. and Japan have continued to negotiate generic security of information provisions for each licensed production and R&D project [Ibid p. 2]. The most serious impact of the lack of a GSOMIA is that it "inhibits the exploration of cooperation in future programs" [Ibid p. 2]. DoD would benefit from conclusion of a GSOMIA because its presence would "facilitate the development and negotiation of MOUs for cooperative programs as well as encourage exchanges of information on future defense planning and requirements [Ibid p. 2]. A GSOMIA would essentially place Japan on an equal footing with other U.S. allies in evaluating synergies in the defense acquisition process. Conclusion of a GSOMIA might also facilitate overcoming the last hurdle described in this section, regulatory reform.

4. Reform and of Rules and Regulations Governing Acquisition Projects with Japan

Two regulations that govern the collaborative acquisition process with Japan are the Arms Export Control Act (AECA) and the Federal Acquisition Regulations (FAR). The U.S. and Japan collaborative process is necessarily complicated by environmental factors (e.g. language differences and organizational structure differences) and these regulations both inhibit and promote participation in collaborative programs. Selected portions of each regulation are examined with respect to their impact on the U.S. - Japan acquisition environment.

a. AECA

FMS co-production is a collaboration alternative and the AECA is the statutory basis for the conduct of FMS.

> The AECA came into being under a different title, i.e., the Foreign Military Sales Act of 1968 (FMSA). Before 1968, the basic authority for foreign military sales was the Foreign Assistance Act of 1961. The FMSA served to incorporate the Foreign Military Sales Program under a new and separate act. The International Security Assistance and Arms Export Control Act of 1976 changed the title of the FMSA to the AECA. This 1976 Act also repealed Section 414 of the Mutual Security Act of 1954 (which provided authority for commercial licensing through the

International Traffic in Arms Regulations); this authority was placed in a new Section 38 (Control of Arms Exports and Imports) of the AECA which governs the licensing and sale of items through direct commercial channels [Ref. 47, "Green Book", Chap 3].

The AECA is a complex document that requires a detailed knowledge of its contents to successfully comply with all of its provisions. While many of the provisions of the AECA may be necessary to ensure adequate control of arms exports, some provisions might be waived or otherwise modified to enable more efficient collaboration with Japan.

b. Federal Acquisition Regulations

The Federal Acquisition Regulations System is established for the codification and publication of uniform policies and procedures for acquisition by all executive agencies. The Federal Acquisition Regulations System consists of the Federal Acquisition Regulations (FAR), which is the primary document, and agency acquisition regulations that implement or supplement the FAR. [Ibid, Part 1].

Several sections of the FAR relate directly to the hurdles previously discussed in this section. The following paragraphs outlined selected FAR sections that apply to the U.S. - Japan acquisition environment.

(1) FAR Part 4.402. The FAR Part 4.402 deals with the security of defense information. Specifically, the FAR Part 4.402 states that DoD is responsible for implementation of "(p)rocedures for the protection of information relating to foreign classified contracts awarded to U.S. industry, and instructions for the protection of U.S. information relating to classified contracts awarded to foreign firms, are prescribed in Chapter 10 of the National Industrial Security Program Operating Manual." [Ibid, FAR, Part 4]. As noted previously, the absence of a GSOMIA may inhibit compliance with this portion of the FAR. Technology transfer issues may also be an issue that relates to compliance with this portion of the FAR. FMS procedures with Japan might be streamlined through conclusion of standardized MOUs that address the security requirements outlined in the FAR Part 4.402.

(2) FAR Parts 9.602 and 9.603. FAR Parts 9.602 and 9.603 advocate contractor teaming (where appropriate) in acquisition projects. Contractor teaming is defined as: "Two or more companies form a partnership or joint venture to act as a potential prime contractor; or a potential prime contractor agrees with one or more other companies to have them act as its subcontractors under a specified Government contract or acquisition program." [Ibid, FAR, Part 9]. FAR Part 9.602 goes on to say that contractor teaming is a desirable arrangement from both a government and industry perspective because teaming

> enables the companies involved to: (1) Complement each other's unique capabilities, and (2) Offer the Government the best combination of performance, cost, and delivery for the system or product being acquired [Ibid, Part 9].

FAR Parts 9.603 and 9.603 emphasize DoD's desire to achieve the Fundamental Objectives outlined earlier in this Chapter. For selected acquisition projects, contractor teaming between U.S. and Japanese firms may facilitate optimization of DoD program objectives.

(3) FAR Part 25.407. The FAR Part 25.407 outlines a standing wavier for Japan from the Buy American Act[13]. Specifically, this section waives the Buy American Act for trade in Civil Aircraft for 23 countries, including Japan. This section of the FAR is particularly relevant given Japan's emphasis on domestic aerospace development and the potential for spin-on technologies in military aircraft. This wavier might be further expanded to include provisions for military aircraft based on civilian airframes (e.g. a Boeing 707 airframe for the P-X).

The AECA and the FAR are only two of the regulations that govern collaborative acquisition projects. The AECA and the FAR can provide the Program Manager with a basic knowledge of the regulatory implications of collaboration with Japan. More detailed information on regulations governing acquisition projects with Japan is available via the website listed at Reference 47.

[13] The Buy American Act restricts "the purchase of supplies, that are not domestic end products, for use within the United States" [Ref. 47, FAR, Part 25].

F. CHAPTER SUMMARY

Specific acquisition opportunities exist for DoD in: the P-X program, the C-X program, and the TMD program. General acquisition opportunities exist for DoD in biometric identification, distributed simulation, and rotary-wing, unmanned aerial vehicles. Four alternatives for collaboration are available to the Program Manager: co-development, co-production, FMS, or don't collaborate. Analysis of these alternatives will provide the Program Manager with an assessment of how collaboration with Japan might (or might not) help to achieve best-value in the acquisition process. Program Managers may use the researcher's assessment tool to evaluate collaboration alternatives with Japan. Acquisition policy has an overarching impact on the implementation of a preferred alternative. Acquisition policy frames the collaborative acquisition environment and Program Managers must be cognizant of the policy issues that impact potential acquisition opportunities. Acquisition opportunities exist for DoD within the JDIB and careful evaluation of these opportunities will likely create an acquisition process that contributes to both Japanese and U.S. goals for systems' acquisition.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This purpose of this thesis was to provide DoD Program Managers with a baseline analysis of the JDIB. There are significant differences between the USDIB and the JDIB, most notably that the JDIB is significantly smaller than the USDIB and firms in the JDIB operate in a virtually non-competitive environment. Despite these differences, similarities do exist between the two industrial bases and these similarities provide opportunities for cooperation in weapons' acquisition. In developing this baseline analysis the researcher was able to derive several conclusions in pursuit of the primary and secondary research questions.

1. General Conclusions

General Conclusion #1: Japan and the U.S. will probably continue to maintain similar, defense-related equipment in the long-term. This commonality of equipment will create regular opportunities to cooperate on acquisition projects

General Conclusion #2: Specific acquisition opportunities exist for DoD in co-development projects that involve maritime patrol aircraft, transport aircraft, and missile defense. Evaluation of key program elements (i.e. cost, schedule, and performance) will assist Program Managers in deciding if, and how, to collaborate with Japan.

2. Specific Conclusions

Specific Conclusion #1: The JDIB can effectively interact with the USDIB on acquisition projects. However, the JDIB's growth potential is severely limited by Japan's current policies on arms exports (i.e. the Three Principles).

Specific Conclusion #2: Past economic factors that have influenced the U.S. Japan interface include: (a) synchronization of macroeconomic issues with DoD acquisition program goals; (b) proper valuation of technology when it is transferred as a part of a collaborative process; (c) optimization of gains through economies of scale and shared overhead costs in production and; (d) use of collaborative R&D to help mitigate program risk and add to the customer base (thus lowering total program cost).

Specific Conclusion #3: The most likely area for future acquisition interface with the JDIB is in defense aerospace.

Specific Conclusion #4: Program Managers can evaluate the costs and benefits of collaborative projects with Japan using additive utility theory, value-focused thinking, or commercially available decision support software.

B. RECOMMENDATIONS FOR THE DEPARTMENT OF DEFENSE

1. Seek Out Acquisition Opportunities with Japan and Evaluate Them

DoD Program Managers should seek out acquisition opportunities with the JDIB in order to promote best-value acquisition of weapons' systems. These opportunities should be evaluated for their relative cost and benefits to determine what form of collaboration is desired. The evaluation may determine that collaboration with the JDIB is not desired.

2. Focus Collaborative Efforts in Defense Aerospace

The three specific areas identified as acquisition opportunities for the U.S. and Japan all fall in the general category of defense aerospace. Japan's preference for collaboration in these types of programs has been established through historical precedent. DoD can optimize cost, schedule and performance parameters in aerospace programs through continued collaboration with Japan

C. AREAS FOR FURTHER RESEARCH

This thesis provides only a baseline analysis of the JDIB and it did not provide a detailed analysis of any currently existing acquisition opportunity. The following areas are recommended for further research in the area of collaborative acquisition:

-Analyze the advantages and disadvantages of collaboration with Japan in a specific program using the researcher's model (e.g. use the MMA/P-X programs).

-Analyze the impacts of current U.S. and Japanese policies on the acquisition environment.

-Develop an alternative model for assessing collaboration with Japan that emphasizes current U.S. - Japan policy imperatives and strategic military considerations.

-Conduct a comparison of how the U.S. conducts collaboration with countries other than Japan (e.g. E.U.) and identify strengths and weaknesses in the current U.S. - Japan collaborative effort.

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APPENDIX A - TEN THINGS PROGRAM MANAGERS SHOULD KNOW ABOUT THE JDIB

1. Twelve companies in the JDIB account for approximately 95% of all Japanese defense contracts.

2. Mitsubishi Heavy Industries (MHI) is the lead producer of Japanese defense equipment and is Japan's only producer of fixed-wing aircraft.

3. Japanese defense firms function in an essentially non-competitive environment.

4. The Three Principles on Arms Exports limit the JDIB to almost purely internal defense production. As a matter of policy, Japan does not export defense-related items.

5. The JDIB competes for a total acquisition budget of approximately $9 billion (procurement and R&D). Most contracts come from the Japanese Defense Agency.

6. Japan procures its defense equipment from five sources: (1) domestic development, (2) co-development with the United States, (3), Licensed Production, (4) Commercial Imports, and (5) Foreign Military Sales (FMS).

7. The most likely areas for acquisition opportunities are in co-development, Licensed Production, and FMS.

8. Japan purchases most of its defense imports from the U.S. but companies within the JDIB do pursue limited projects with other countries (e.g. the E.U.).

9. The JDIB is heavily involved in aerospace R&D and views aerospace R&D as the most prolific area for commercial application spin-offs.

10. Initial evaluation of collaboration opportunities with the JDIB should be undertaken prior to Milestone A to ensure a full range of collaboration opportunities are examined.

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APPENDIX B - SUMMARY OF COOPERATIVE U.S. - JAPAN RESEARCH PROJECTS

(1) Ducted Rocket Engine. This first JDA-DoD cooperative R&D project was established in 1992. The $30M, five year US Army/Technical Research and Development Institute (TRDI) project developed and ground tested a flight–weight ducted rocket engine with potential application to surface to air missile systems. US Army Missile Command and TRDI each contracted with domestic firms for engine components, fuel, and testing components (Nissan, Nippon Oils & Fats, Alliant Tech Systems, and UTC participated); final integration and testing was conducted by MICOM and TRDI. The program was completed in 1999.

(2) Advanced Steel Technology. Established in 1995, this $35M US Navy/TRDI project aims to develop new methods for welding high strength steels using under-matched welding techniques. Potential applications for the DOD include aircraft carrier and submarine hull construction. Each side is fabricating test articles, conducting tests on its own and the other side's test articles, and sharing technical information. Industry participants are MHI, KHI, Nippon Steel, USX, Lukens, Bethlehem Steel, Oregon Steel. Several government labs and universities are also involved.

(3) Fighting Vehicle Propulsion using Ceramic Materials. Established in 1995, this $25M US Army TACOM/TRDI project aims to develop breakthrough diesel engine technology for ground vehicles with emphasis on high power density and low fuel consumption through the use of ceramic materials. Industry participants are Isuzu, MHI, Cummins Engine Company, Caterpillar Inc., and Detroit Diesel Corporation. Each side is constructing a one-cylinder test engine and will share technical information, test results, and components.

(4) Eye-Safe Laser Radar. Established in 1996, this $20M US Army CECOM/TRDI project is developing and testing a demonstrator multifunction eye-safe laser radar system capable of range finding, range mapping, target profiling, and obstacle warning and avoidance.

(5) ACES II Ejection Seat Modification. Established in 1998, this $50M USAF/Japan Air Self Defense Force (JASDF) project is developing and evaluating a modification kit for the ACES II ejection seat used in F-15 and other aircraft. The kit will increase the stability of the seat and reduce limb flailing to reduce injury potential in high-speed ejections. The modification will also increase the anthropometrical dimensions that the seat can safely accommodate. Contractors include MHI, Daicel and Boeing.

(6) Advanced Hybrid Propulsion Technologies. Established in 1998, this $18M USAF/TRDI project is conducting research and exploratory development of advanced hybrid rocket engine propulsion to increase the performance, safety, and reliability of future tactical missiles. The project will develop liquid oxidizers, gas generator fuels,

flow control systems, combustion technology, and other supporting technology. This will enable demonstration of a forward injected gas generator hybrid rocket engine with energy management capability.

(7) Shallow Water Acoustic Technologies (SWAT). Established in 1999, this $2-3M US Navy/ TRDI project will formulate an exchangeable data base and explore interoperable system concepts in the areas of environmental measurement, sound propagation/reverberation modeling, and signal processing/artificial intelligence in shallow water environments.

(8) Cooperative Ballistic Missile Defense Research: Established in 1999, this $70M program is performing requirements analysis and design for anti-ballistic missile components. The potential application for this work is the future SM-3 Block II missile associated with the Navy Theater Wide system. Research is focused on the Sensor, Advanced Kinetic Warhead, Propulsion, and Lightweight Nosecone.

(9) Low Vulnerability Ammunition (LOVA). This just-initiated $1.5 - 2M program between the US Army and TRDI seeks to develop low cost, reduced sensitivity energetics for use as propellant in artillery systems. This program will involve exchanges of energetic plasticizers and the propellant cellulose acetate nitrate, formulations work, and characterization of the physical and chemical properties of the samples. The Army and TRDI would conduct testing in a small caliber gun and aging studies, as well as bullet impact, fast cook off, and fragment impact tests.

From: Ref. 39 pp. 3-4.

APPENDIX C-TOP TEN U.S. AND JAPANESE DEFENSE FIRMS IN 1982[14]

Rank	U.S. Firms	Japanese Firms
1	McDonnell Douglas Corp.*	Mitsubishi Heavy Industries
2	General Dynamics Corp.	Kawasaki Heavy Industries
3	General Electric Co.	Mitsubishi Electric Corp.
4	Tenneco Inc.	Ishikawajima-Harima Heavy Industries
5	Raytheon Co.	Toshiba Corp.
6	Martin Marietta Corp.**	NEC
7	General Motors Corp.	Fuji Heavy Industries
8	Lockheed Corp.	Japan Steel Works
9	United Technologies Corp.	Sumitomo Heavy Industries
10	The Boeing Co.	Komatsu Corp

*Merged with Boeing Co.
**Merged with Lockheed Corp.

From: Ref. 12 p. 21 and Ref. 21 p. 94.

[14] See Table 4 p. 21 for a comparison of U.S. and Japanese firms in 2000

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APPENDIX D - ROOTS TO FRUITS MODEL OF JAPANESE AEROSPACE INDUSTRY

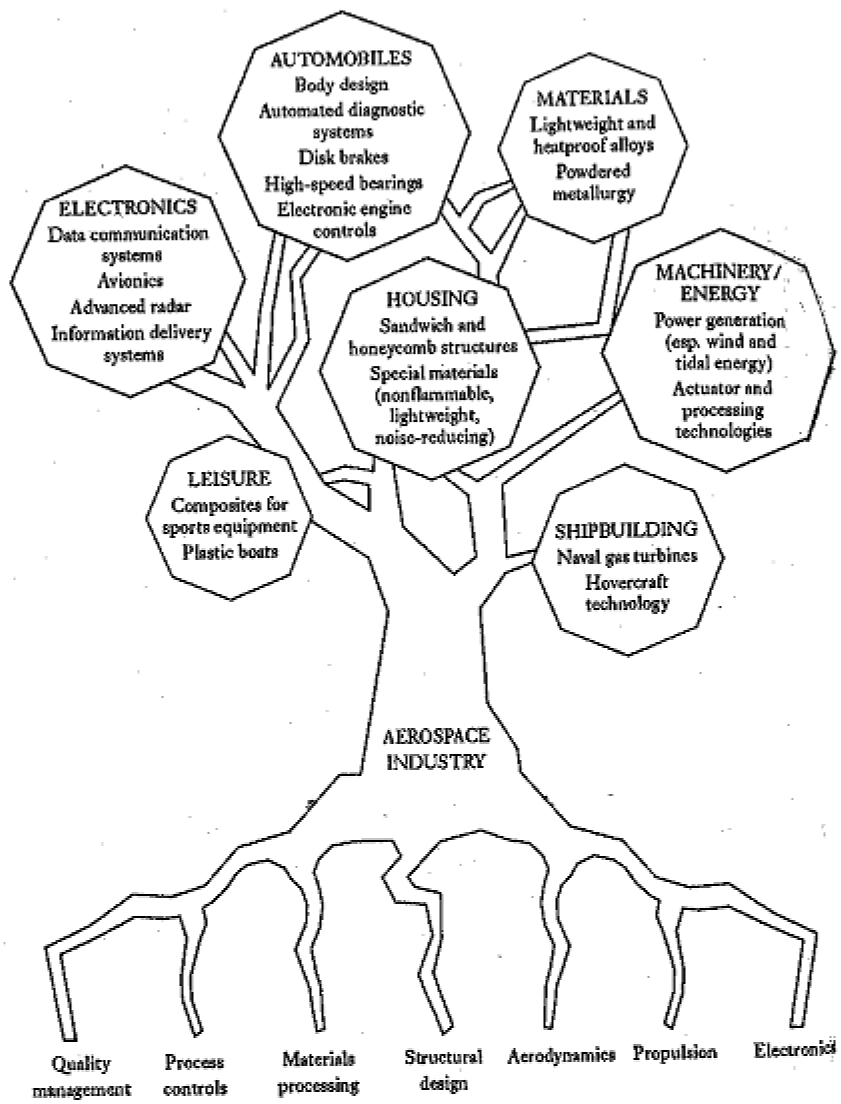

Figure 2. Roots to Fruits Model of Japanese Aerospace Industry
From: Ref. 44 p. 246.

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APPENDIX E - PROS AND CONS OF COLLABORATIVE PROGRAMS

	Type of Program		
Objective	Reciprocal Trade	Cooperative Production[a]	Co-development
Economic	**Pro**: Specialization by U.S. and partners increases size of market and reduces costs. **Con**: U.S. loses R&D and production capabilities for weapons outside area of specialization.	**Pro**: Specialization of production, larger market reduces costs while U.S. still able to maintain R&D and some production capability. **Con**: Duplication of production, small size, and inexperience of partners raise costs for U.S.	**Pro**: Shared costs of R&D and production, larger market to reduce costs, allowing U.S. to maintain wider range of R&D and production capabilities. **Con**: Unintentional transfer of technology may harm more advanced U.S. industry. Greater risk of cost growth and schedule slippage
Operational	**Pro**: U.S. and partners share common equipment. **Con**: U.S. requirements compromised; independent U.S. capability diminished	**Pro**: U.S. and partners share common equipment. **Con**: Significant difference between models produced by partners	**Pro**: U.S. and partners share common equipment. **Con**: U.S. requirements compromised; independent U.S. capability diminished. Significant difference between models produced by partners
Political	**Pro**: Partners strengthen political ties through military reliance. Common equipment encourages shared training and doctrine **Con**: Compromised requirements, loss of independent capability strain political ties	**Pro**: U.S. able to influence partners' defense postures. Common equipment encourages shared training and doctrine. **Con**: Disagreements over program management strain political ties.	**Pro**: Better than partners developing independent R&D capability. Common equipment encourages shared training and doctrine. **Con**: Compromised requirements, loss of independent capability strain political ties
[a]Assumes licenser is United States			

From: Ref. 29 p. 8

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APPENDIX F - ASSESSEMENT TOOL FOR EVALUATION OF ACQUISITION OPPORTUNITES WITH JAPAN (GENERIC FORMAT)

		Utilities of Alternatives			
Objectives	**%**	**Co-devel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**
Minimize Cost (33.2%)					
Share RDT&E Costs	0%	0.00	0.00	0.00	0.00
Gain Economies of Scale	0%	0.00	0.00	0.00	0.00
Take Adv. of the Kokusanka Effect	0%	0.00	0.00	0.00	0.00
Maximize Tech. Trans. Costs and Ben.	0%	0.00	0.00	0.00	0.00
Integrate Comm. Items and Best Prac.	0%	0.00	0.00	0.00	0.00
Subtotals	*0%*	***0.00***	***0.00***	***0.00***	***0.00***
Minimize Schedule Risk (22.6%)					
Min. Sched. Risks in Bilateral RDT&E	0%	0.00	0.00	0.00	0.00
Take Advantage of JDIB Proficiency	0%	0.00	0.00	0.00	0.00
Create Positive Congressional Interest	0%	0.00	0.00	0.00	0.00
Integrate Comm. Items and Best Prac.	0%	0.00	1.00	0.00	0.00
Subtotals	*0%*	***0.00***	***0.00***	***0.00***	***0.00***
Maximize Performance (44.2%)					
Use Shared RDT&E	50%	1.00	0.13	0.00	0.00
Enhance Interoperability	10%	0.00	0.00	0.00	0.00
Integrate Comm. Items and Best Prac.	40%	0.00	0.00	0.00	0.00
	0%	0.00	0.00	0.00	0.00
Subtotals	100%	***22.10***	***2.87***	***0.00***	***0.00***
Weighted Utility Score		**22.10**	**2.87**	**0.00**	**0.00**

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APPENDIX G - FUNDAMENTAL OBJECTIVES HIERACHY FOR COLLABORATION ALTERNATIVES WITH THE JDIB

- **Minimize Cost**
  - Share RDT&E Costs
  - Gain Economies of Scale
  - Take Advantage of the Kokusanka Effect
  - Maximize Tech. Trans. Costs and Ben.
  - Integrate Commercial Items and Best Prac.
- **Minimize Schedule Risk**
  - Minimize Schedule Risk in Bilateral RDT&E
  - Take Advantage of JDIB Proficiency
  - Create Positive Congressional Interest
  - Integrate Commercial Items and Best Prac.
- **Maximize Performance**
  - Use Shared RDT&E to Maximize Performance
  - Gain Interoperability
  - Integrate Commercial Items and Best Prac.

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APPENDIX H - SCALING TECHNIQUE FOR RATIO COMPARISON

1. To scale the utility assessments so that they range from 0 to 1 the first step is to develop two equations that represent and high and low values of the initial assessment (this example uses the values from the text):

$$\mathbf{0 = a + b(0)}$$

$$\mathbf{0 = a + b(75)}$$

2. The second step is to solve these two equations simultaneously for the constants (a) and (b): **a = 0, b = 1/75**

3. The third step is to apply these scaling constants to calculate the utility value for each collaboration alternative:

$$\mathbf{Utility_{Co\text{-}Dev} = 0 + 75/75 = 1.0}$$

$$\mathbf{Utility_{Lic.\ Prod.} = 0 + 10/75 = 0.13}$$

$$\mathbf{Utility_{FMS} = 0 + 0/75 = 0}$$

$$\mathbf{Utility_{Do\ not\ Coll.} = 0 + 0/75 = 0}$$

4. The final step is to transfer these scaled utilities to the tool.

From: Ref 63 p. 54.

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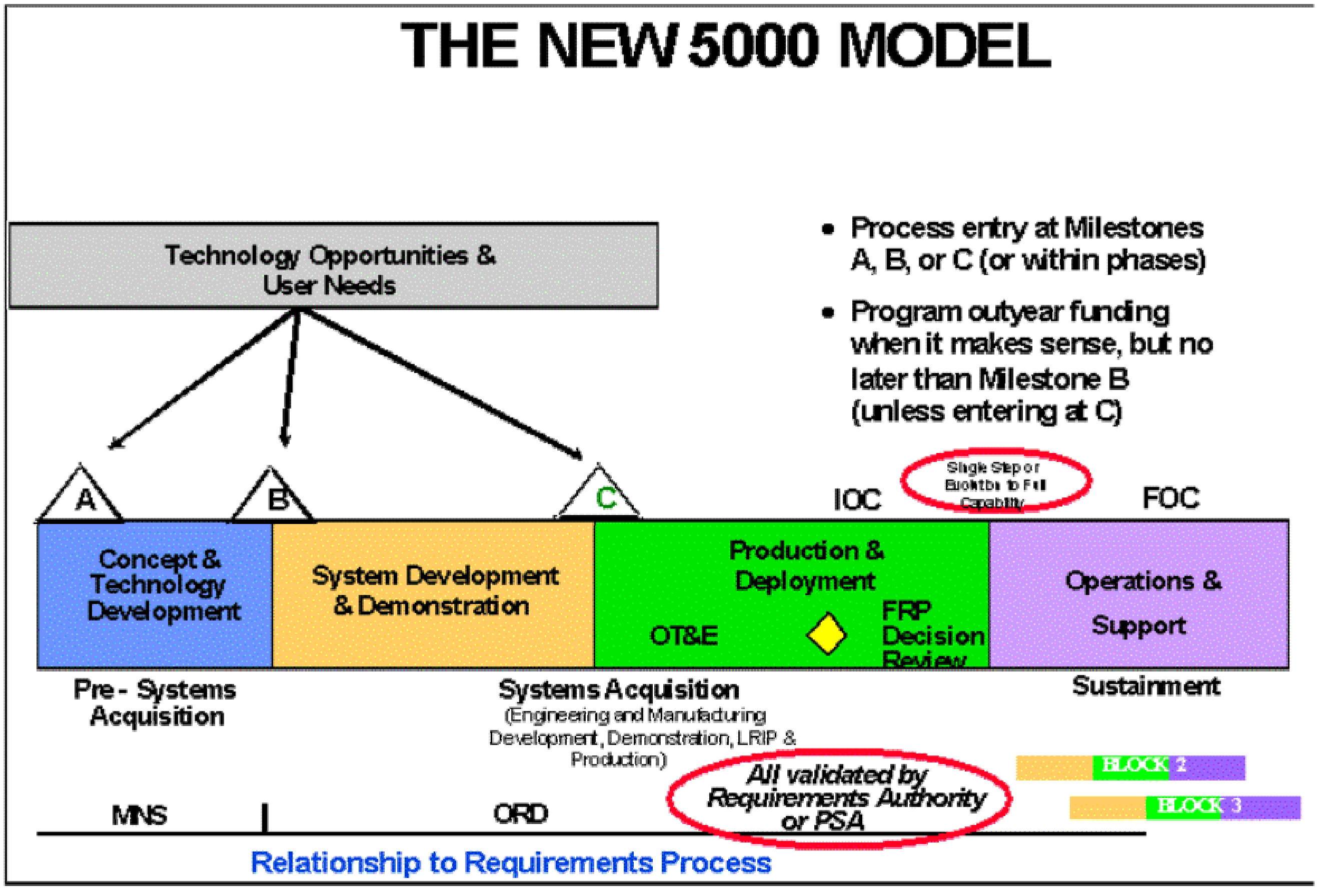
APPENDIX I - THE DOD ACQUISITION PROCESS



From: DoD Instruction 5000.2 as retrieved from Ref. 48.

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APPENDIX J - WEIGHTING AND UTILITY CALCULATIONS FOR FS-X SAMPLE APPLICATION

		Utilities of Alternatives			
Objectives	**%**	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**
Minimize Cost (33.2%)					
Share RDT&E Costs	8.3%	1.00	0.00	0.13	0.00
Gain Economies of Scale	8.3%	0.00	0.33	1.00	0.11
Take Adv. of the Kokusanka Effect	41.7%	1.00	0.75	0.38	0.00
Maximize Tech. Trans. Costs and Ben.	33.3%	0.00	0.30	1.00	0.70
Integrate Comm. Items and Best Prac.	8.3%	0.00	1.00	0.50	0.00
Subtotals	*100%*	***15.00***	***15.70***	***18.75***	***7.27***
Minimize Schedule Risk (22.6%)					
Min. Sched. Risks in Bilateral RDT&E	5.6%	0.00	1.00	0.81	0.50
Take Advantage of JDIB Proficiency	33.3%	0.33	1.00	0.67	0.00
Create Positive Congressional Interest	55.6%	0.00	0.00	0.78	1.00
Integrate Comm. Items and Best Prac.	5.6%	0.00	1.00	0.50	0.00
Subtotals	*100%*	***2.22***	***8.90***	***14.56***	***11.68***
Maximize Performance (44.2%)					
Use Shared RDT&E	31.3%	0.00	1.00	0.50	0.00
Enhance Interoperability	62.5%	0.10	0.50	1.00	0.00
Integrate Comm. Items and Best Prac.	6.3%	1.00	0.00	0.00	0.00
Subtotals	100%	***6.28***	***31.28***	***39.08***	***0.00***
Weighted Utility Score		**23.50**	**55.87**	**72.38**	**18.95**

WEIGHTS FOR FUNDAMENTAL AND DETAILED OBJECTIVES

WEIGHTS FOR FUNDAMENTAL OBJECTIVES

Fundamental Objective	Outcome	Rank	Rate	Weight
(Benchmark)	Highest Cost, Worst Performance, Most Schedule Risk	4	0	N/A
Minimize Cost	Lowest Cost, Worst Performance, Most Schedule Risk	2	60	30.0%
Minimize Schedule Risk	Least Schedule Risk, Highest Cost, Worst Performance	3	40	20.0%
Maximize Performance	Best Performance, Most Schedule Risk, Highest Cost	1	100	50.0%
		Total	200	100%

WEIGHTS FOR DETAILED OBJECTIVE-COST

Detailed Objective	Outcome	Rank	Rate	Weight
(Benchmark)	No Objective Realized	6	0	N/A
Share RDT&E Costs	RDT&E costs shared, Worst on all others	4	20	8.3%
Gain Economies of Scale	Realize EOS, Worst on all others	3	20	8.3%
Take Advantage of the Kokusanka Effect	Advantages of Kokusanka Effect realized, Worst on all others	1	100	41.7%
Maximize Tech. Trans. Costs and Ben.	Tech Transfer Costs and Ben. maximized, Worst on all others	2	80	33.3%
Integrate Comm. Items and Best Prac.	Comm. Items and Prac. integrated, Worst on all others	5	20	8.3%
		Total	240	100%

WEIGHTS FOR DETAILED OBJECTIVE-SCHEDULE

Detailed Objective	Outcome	Rank	Rate	Weight
(Benchmark)	No Objective Realized	5	0	N/A
Minimize Schedule Risks in Bilateral RDT&E	RDT&E schedule risks minimized, Worst on all others	3	10	5.6%
Take Advantage of JDIB Proficiency	Advantages in JDIB Proficiency realized, Worst on all others	2	60	33.3%
Create Positive Congressional Interest	Positive Congressional Interest created, Worst on all others	1	100	55.6%
Integrate Comm. Items and Best Prac.	Comm. Items and Prac. integrated, Worst on all others	4	10	5.6%
		Total	180	100%

WEIGHTS FOR DETAILED OBJECTIVE-PERFORMANCE

Detailed Objective	Outcome	Rank	Rate	Weight
(Benchmark)	No Objective or Realized	4	0	N/A
Use Shared RDT&E to Max. Perf.	RDT&E used to max. perf., Worst on all others	2	50	31.3%
Enhance Interoperability	Max. gain to Interoperability, Worst on all others	1	100	62.5%
Integrate Comm. Items and Best Prac.	Comm. Items and Prac. integrated, Worst on all others	3	10	6.3%
		Total	160	100%

RATIO SCORING OF DETAILED OBJECTIVES ON EACH ALTERNATIVE

Fundamental Objective:	**Minimize Cost**								
Detailed Objective:	**Share RDT&E Costs**								
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0	Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	=	1.00

Fundamental Objective:	**Minimize Cost**								
Detailed Objective:	**Gain Economies of Scale**								
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0	Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	=	1.00

Fundamental Objective:	**Minimize Cost**								
Detailed Objective:	**Take Advantage of the Kokusanka Effect**								
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0	Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	=	1.00

Fundamental Objective:	Minimize Cost								
Detailed Objective:	**Maximize Tech. Trans. Costs and Ben.**								
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0	Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	=	1.00

Fundamental Objective:	Minimize Cost								
Detailed Objective:	**Integrate Comm. Items and Best Prac.**								
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0	Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	=	1.00

Fundamental Objective:	Minimize Schedule Risk								
Detailed Objective:	**Minimize Schedule Risks in Bilateral RDT&E**								
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0	Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	=	1.00

Fundamental Objective:	Minimize Schedule Risk							
Detailed Objective:	**Take Advantage of JDIB Proficiency**							
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**	
Unscaled Utility	0	0	0	0	Low Score	0	a	= 0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	= 1.00

Fundamental Objective:	Minimize Schedule Risk							
Detailed Objective:	**Create Positive Congressional Interest**							
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**	
Unscaled Utility	0	0	0	0	Low Score	0	a	= 0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	= 1.00

Fundamental Objective:	Minimize Schedule Risk							
Detailed Objective:	**Integrate Comm. Items and Best Prac.**							
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**	**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**	
Unscaled Utility	0	0	0	0	Low Score	0	a	= 0.00
Scaled Utility	0.00	0.00	0.00	0.00	High Score	1	b	= 1.00

Fundamental Objective:	Maximize Performance									
Detailed Objective:	**Use Shared RDT&E to Max. Perf.**									
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**		**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0		Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00		High Score	1	b	=	1.00

Fundamental Objective:	Maximize Performance									
Detailed Objective:	**Enhance Interoperability**									
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**		**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0		Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00		High Score	1	b	=	1.00

Fundamental Objective:	Maximize Performance									
Detailed Objective:	**Integrate Comm. Items and Best Prac.**									
Alternative	**Codevel.**	**Licensed Prod.**	**FMS**	**Do not Collab.**		**Scaling Factors**	**Unscaled Scores**	**Scaling Constants**		
Unscaled Utility	0	0	0	0		Low Score	0	a	=	0.00
Scaled Utility	0.00	0.00	0.00	0.00		High Score	1	b	=	1.00

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LIST OF REFERENCES

1. Aerospace Daily, "Top Ten Japanese Defense Contractors for FY 2000", 24 April, 2001, Vol. 198, No. 17, p. 5, The McGraw Hill Companies Inc.

2. Bender, Bryan, "The World/Japan; Self-Defense Forces May Soon Look Like a Modern Military," The Los Angeles Times, Los Angeles, CA, 10 June 2001.

3. Boeing Co., Press Release, "Boeing, Mitsubishi Heavy Industries Confirm Expanded Relationship", Retrieved 26 January 2002 from the World Wide Web: www. defense-aerospace.com

4. Boeing Corporation and Mitsubishi Heavy Industries Ltd., "MB-XX a Japan-US Collaboration Success Story", PowerPoint Presentation delivered at the U.S. - Japan Science and Technology Forum, 14 May 2002.

5. Cable News Network, Online Article "Japan Anti-terror Bill Set for Approval", Retrieved 18 October 2001 from the World Wide Web: www.cnn.com

6. Chinworth, Michael W., "Country Survey XIII: Japan's Security Posture and Defense Industry Prospects," Defense and Peace Economics, Vol. 11, No. 4, July 2000.

7. Chinworth, Michael W., James E., "Report of the Thirteenth Annual U.S. - Japan Technology Forum", May, 2002, Center for U.S. - Japan Studies and Cooperation, Vanderbilt University Institute for Business and Public Policy.

8. Chinworth, Michael W., James E., "Report of the Twelfth Annual U.S. - Japan Technology Forum", undated summary, Center for U.S. - Japan Studies and Cooperation, Vanderbilt University Institute for Business and Public Policy.

9. Clemen, Robert T., Making Hard Decisions-An Introduction to Decision Analysis, 2nd Ed., Duxbury Press, Pacific Grove, CA, 1996.

10. Cohen, Steven, E-mail response to researcher's query, 28 February 2002.

11. Cummings, Andrew, "The U.S. Japan Alliance is Vital", Naval Institute, Proceedings, March 2002, Retrieved 4 April 2002, from the World Wide Web via the ProQuest database.

12. Department of Defense, Defense 82, American Forces Information Service, Arlington, Virginia, September 1982.

13. Department of Defense, Summary of Procurement Awards (Format Sum) OCT 1996 - SEP 1997, Retrieved 25 March 2002 from the World Wide Web: web1.whs.osd.mil

14. Deutch, John, "Consolidation of the U.S. Defense Industrial Base", Acquisition Review Quarterly, Fall 2001.

15. Eurocopter, Press Release, "Eurocopter and Kawasaki Heavy Industries Jointly Develop New BK117 Version", Retrieved 26 Jan 2002 from the World Wide Web: www. defense-aerospace.com

16. Genalis, Paris, "International Defense Procurement Challenges and Opportunities", Retrieved 15 November 2001 from the World Wide Web: www.dsmc.mil

17. Gordon, Mitchell R., "Japan-U.S. Missile Defense Collaboration: Rhetorically Delicious, Deceptively Dangerous", The Fletcher Forum of World Affairs, Medford, Maryland, Winter 2001, Retrieved 16 October 2001 from the World Wide Web at www.pitt.edu

18. Government Executive Magazine, "1999 Defense Foreign Military Sales Contractors", Retrieved 24 January 2002 from the World Wide Web: www.fas.org

19. Gross, David T., "U.S. - Japan Industrial Relationships in the Aegis Foreign Military Sales Program, Retrieved 19 April 2002 from the World Wide Web: bob.nap.edu

20. Hellman, Christopher, "Top 15 U.S. Defense Contractors for FY '99", Center for Defense Information, Retrieved 13 December 2001 from the World Wide Web: www.cdi.org

21. Industrial Review of Japan/1984, The Japan Economic Journal, Nihon Keizai Shimbun, Toyko, Japan, April 1984.

22. Iwata, Norio, "Procurement Policy and Defense Industry in Japan", DISAM Journal of International Security Assistance Management, Wright-Patterson AFB, Summer, 1999.

23. Jane's Aircraft Upgrades 2001-2002, "Kawasaki C-1", Jane's Information Group, 13 August 2001, Retrieved 29 July 2002 from the World Wide Web at www.janes2.com

24. Jane's All the World's Aircraft, "Kawasaki C-X and MP-X", Jane's Information Group, 30 May 2002, Retrieved 29 July 2002 from the World Wide Web at www.janes2.com

25. Japan Defense Agency, Defense of Japan, 2000, Urban Connections, Japan, 2000.

26. Jochum, James J., "Prepared Testimony before the House Armed Services Committee", February 28, 2002, Retrieved 25 March 2002 from the World Wide Web at www.bxa.doc.gov

27. Kenney, Ralph L., "Creativity in MS/OR: Value-Focused Thinking-Creativity Directed toward Decision Making", The Institute of Management Sciences, Los Angeles, California, 1993.

28. Lorell, Mark A., "Conflicting U.S. Objectives in Weapon System Co-development: the FS-X Case", RAND, Santa Monica, CA, August 1995, Retrieved 26 January 2002, from the World Wide Web at www.rand.org

29. Lorell, Mark A., Lowell, Julia A., Pros and Cons of International Weapons Procurement Collaboration, RAND, Santa Monica, CA, 1995.

30. Lorell, Mark A., Troubled Partnership, A History of U.S. - Japan Collaboration on the FS-X Fighter, RAND, Santa Monica, CA 1995.

31. Mitsubishi Heavy Industries Ltd., "Japan/US Cooperative BMD Project-Industry Perspective", PowerPoint Presentation delivered at the U.S. - Japan Science and Technology Forum, 14 May 2002.

32. Office of the Deputy Undersecretary of Defense for Industrial Policy, Online Article, "Frequently Asked Questions", Retrieved 10 January 2002 from the World Wide Web: www.acq.osd.mil.

33. Office of the Secretary of Defense, "General Security of Military Information Agreement (GSOMIA) and Japan", Undated, provided via e-mail 6 March 2002.

34. Office of the Secretary of Defense," Japan Defense Agency Budget, Implications for Acquisition Programs and Japanese Industry", Undated, provided via e-mail 6 March 2002.

35. Office of the Secretary of Defense, "Japan's Future Maritime Patrol Aircraft", Undated, provided via e-mail 6 March 2002.

36. Office of the Secretary of Defense, "Major Defense Acquisition Program (MDAP) List", Department of Defense, Washington D.C., 29 May 2002, Retrieved 29 July 2002 from the World Wide Web at extranet.acq.osd.mil

37. Office of the Secretary of Defense, "Missile Defense R&D Cooperation with Japan" Undated, provided via e-mail 6 March 2002.

38. Office of the Secretary of Defense, "Top 10 Companies", Retrieved 25 March 2002 from the World Wide Web at web1.whs.osd.mil

39. Office of the Secretary of Defense, "US-Japan Systems and Technology Forum Background – and Proposed Evolution", Undated, provided via e-mail 6 March 2002.

40. Online Article, "FS-X/F-2 Fighter Support Experimental", Retrieved 10 May, 2002, from the World Wide Web: www.f-16.net

41. Online Article, "Japan", The Bureau of Export Administration, United States Department of Commerce, Washington, D.C. Retrieved 16 October 2001 from the World Wide Web: www.doc-bxa.bmpcoe.org

42. Online Article, "Mid-Term Defense Plan", Retrieved 22 January 2002 from the World Wide Web: www.jda.go.jp

43. Rubenstein, Gregg A., "Future Cooperation in U.S. - Japan Defense Programs", Presentation delivered at the 13th Annual U.S. - Japan Technology Forum 14 May 2002.

44. Samuels, Richard J., Rich Nation, Strong Army, Cornell University Press, Ithaca, New York, 1994.

45. Satty, Thomas L. et al., Expert Choice, Decision Support Software, User Manual, Decision Support Software Inc., McLean, Virginia.

46. Solarz, Stephen J. Rep., "Foes of Aegis Sale to Japan Miss the Boat", The Wall Street Journal, New York, New York, 1 August 1998.

47. Defense Acquisition Deskbook, Various Cites, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, 28 Feb 2002, Retrieved 12 July 2002, from the World Wide Web: web1.deskbook.osd.mil/default.asp

48. Department of Defense Directive 5000. Department of Defense, Washington, D. C., New DOD 5000 Series. Retrieved 12 July 2002 from the World Wide Web: www.web2.deskbook.osd.mil/default.asp

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